Nationaal Lucht- en Ruimtevaartlaboratorium
National Aerospace Laboratory NLR

AMS Tracker Thermal Control Subsystem

TTCB EMI/EMC Test Report

AMSTR-NLR-TRP-008
ISSUE 1.0
JUNE 2009

Sun Yat-Sen University (SYSU)
National Aerospace Laboratory (NLR)
Instituto Nazionale di Fisica Nucelare (INFN)

	NAME	ORGANISATION/RESPONSIBILITY	SIGNATURE	DATE
PREPARED	J. van Es/Z. Zhang	NLR		
CHECKED	J. van Es	NLR / AMS SE		
AGREED	A. Pauw	NLR / AMS PA		
APPROVED	J. van Es	NLR / AMS PM		
AUTHORISED	P. Dieleman	NLR Space Department		

FILENAME	AMSTR-NLR-TEMP-001_1.0work_Document_Template.doc	ORDER-/CODENUMBER:	2494047
LAST SAVED	2009.06.30 13:08 by J. van Es	DIVISION:	AS&A
PRINTED	2009.06.30 18:44	DISTRIBUTION:	Unlimited
PAGES	51	CLASSIFICATION TITLE:	Unclassified

Distribution list

Company	*FOR**	*Name*	*Comments*
SYSU	I	Z.H. He	
		X. Qi	
		T. Li	
INFN	I	R. Battiston	
		M. Menichelli	
		C. Gargiulo	
		A. Alvino	
		E. Laudi	
AMS	I	M. Capell	
		V. Koutsenko	
		R. Becker	
NLR	I	P. Dieleman	
		J.van Es	
		M. Bardet	
Jacobs Sverdrup	I	C. Tutt	
		G. Clark	
CGS	I	M. Molina C. Vettore	

A = Approval
R = Review
I = Input / Information

An electronic version of this document is available on the AMS TTCS website:

https://ams-ttcs.nlr.nl

Document change log

Change Ref.	*Section(s)*	*Issue 1.0*
-	All	Initial issue

Summary

This report shows the test results of the EMI/EMC testing of the TTCB-P box.
The tests were performed at the CEM laboratory in Terni Italy. The test was supported by NLR, INFN and SYSU.
All TTCB and TTCE radiated emission are below the requirement levels.
TTCB/TTCE survived the EMC test campaign. No degradation in functional behaviour was found after the test.
However the TTCB/TTCE set-up showed to be susceptible to both horizontal and vertical H-fields (200 MHz-1 GHz).

The following anomalies take place in the H-field:

1. Pump speed increase upto approximately additional 3500 rpm
2. Probable a communication problem resulting in pump switch off
3. Pt1000 increase with max 4 degrees ^{o}C
4. DS increase of maximum 2.5 ^{o}C. Especially spare DS (not attached to any construction) are susceptible (DS14 & DS16).
5. APS noise

Contents

(51 pages in total)

1 Scope of the document

The document shows the (functional) test data performed during the tests. Additional information to this test report can be found in the filled procedure sheets of

2 References documents

Ref	Title	Number
RD-1	TTCB EMC EMI procedure	AMSTR-NLR-PR-029
RD-2	TTCB EMC EMI procedure Part B	AMSTR-NLR-PR-029

3 Test Set-up description

4 Hardware under test

The TTCB-p flight module. The TTCB was operational during EMC/EMI test and therefore connected to Ground Support Equipment to form a closed loop filled with CO2. The GSE-loop will be equipped with a mass flow meter, absolute pressure transducer, differential pressure transducer and temperature sensors.

5 Test Programme

5.1 Part A: EMI radiation emission tests (performed on June 10)

During the emissivity test the following actuator will be switched on to measure the emission. If possible the actuators will be switched on separately, no other actuators active or as less as possible.

	Actuator	Pump running	comment
1	Peltier elements	no	PWM, 10 %
2	Accumulator heater FAC	no	PWM, 90 % (TBC)
3	TTCB pump	yes	3500, 6000, 10000 RPM
4	Pre-heater	yes (minimal flow)	Manual ON/OFF (2s/10s)
5	Start Up Heater	yes (minimal flow)	Manual ON/OFF (2s/10s)
6	Cold Orbit Heater	yes (minimal flow)	Manual ON/OFF (2s/10s)

Test Abbrevation	**Test name and Frequency range**				
	Day 1	2009-06-10			
	Radiated Emission Test			**14 KHz**	**15.5 GHz**
A	KHz	14	150	KHz	
B	KHz	150	30	MHz	
C (Hor)	MHz	30	300	MHz	POL H
C (Ver)	MHz	30	300	MHz	POL V
D (Hor)	MHz	300	700	MHz	POL H
D (Ver)	MHz	300	700	MHz	POL V
E (Hor)	GHz	700	1	GHz	POL H
E (Ver)	GHz	700	1	GHz	POL V
F (Hor)	GHz	1	15.5	GHz	POL H
F (Ver)	GHz	1	15.5	GHz	POL V

5.2 Source of interference during zero-field reference measurements

During the zero-field test prior to testing three sources of interference were found:

1. CAN-controller connection. With the Can-box grounded and a linear power supply the problem was solved.
2. NI DAC unit was also interfering. This was solved by changing the power supply.

The thermal bath was also producing interfering fields. This was solved to switch the bath off during the susceptible EMI test.

During the EMI test it was found that in most case the pump did not induce any EMI problem. Therefore the pump was ran in more cases then stated in section 5.1 and heaters could be operated during longer times.

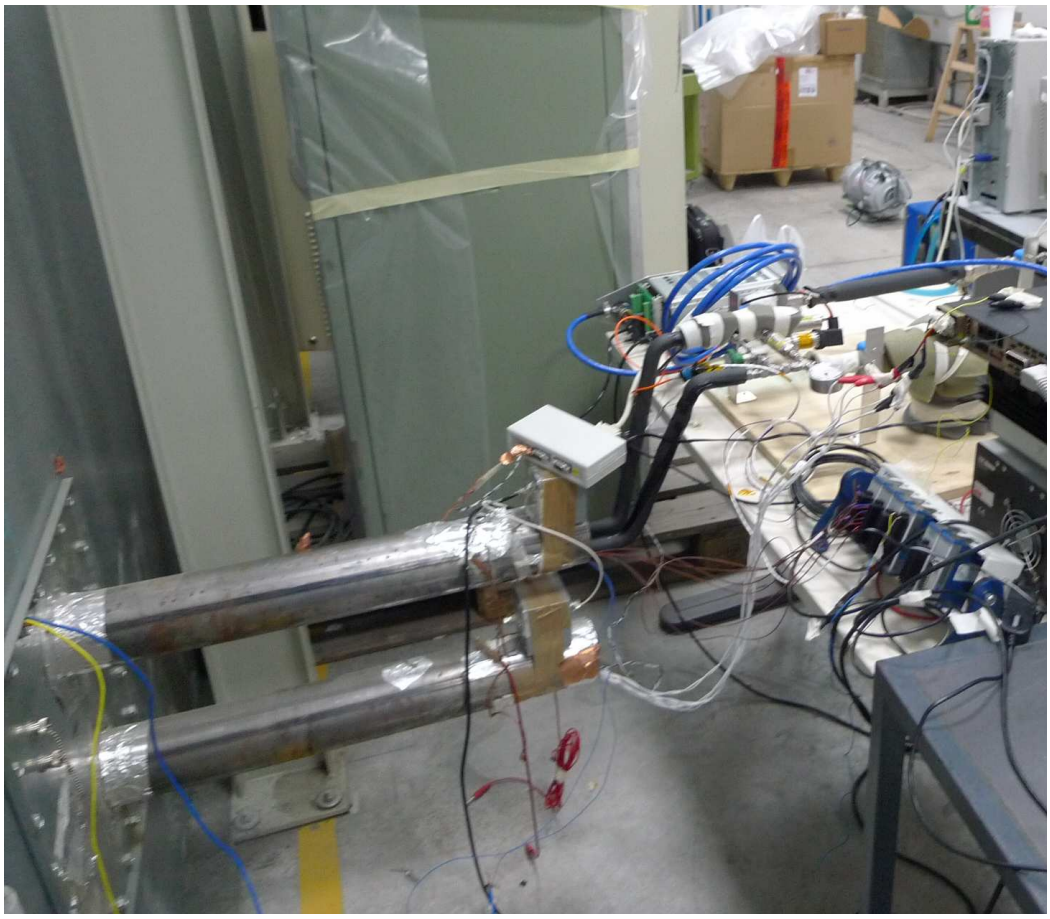


Figure 5-1: Can controller grounding on EMC chamber ground

5.3 Part B: EMC interference measurements

The EMC/EMI overall test sequence is:

Test Abbrevation	Test name and Frequency range				
	Day 1	2009-06-10			
	Radiated Emission Test			**14 KHz**	**15.5 GHz**
A	KHz	14	150	KHz	
B	KHz	150	30	MHz	
C (Hor)	MHz	30	300	MHz	POL H
C (Ver)	MHz	30	300	MHz	POL V
D (Hor)	MHz	300	700	MHz	POL H
D (Ver)	MHz	300	700	MHz	POL V
E (Hor)	GHz	700	1	GHz	POL H
E (Ver)	GHz	700	1	GHz	POL V
F (Hor)	GHz	1	15.5	GHz	POL H
F (Ver)	GHz	1	15.5	GHz	POL V
	Day 2	2009-06-11			
	Radiated Spikes		**(RS-02)**		
				minutes	# TTCB CONF
Spike 1	pulses		10 micro	1	13
Spike 2			150 nano	1	13

	Radiated	Electric field level		(RS03)	
G	Khz	14	10	Mhz	
H (Hor)	MHz	**200**	**1**	GHz	POL H
H (Ver)	MHz	**200**	**1**	GHz	POL V
I (Hor)	GHz	1	2	GHz	POL H
I (Ver)	GHz	1	2	GHz	POL V
J (Hor)	GHz	**2**	**4**	GHz	POL H
J (Ver)	GHz	**2**	**4**	GHz	POL V
K (Hor)	GHz	4	8	GHz	POL H
K (Ver)	GHz	4	8	GHz	POL V
L (Hor)	GHz	**8**	**10**	GHz	POL H
L (Ver)	GHz	**8**	**10**	GHz	POL V
M (Hor)	GHz	2.2		GHz	POL H
M (Ver)	GHz	2.2		GHz	POL V
N (Hor)	**GHz**	**8.5**		GHz	POL H
N (Ver)	**GHz**	**8.5**		GHz	POL V
O (Hor)	GHz	13.7	15.2	GHz	POL H
O (Ver)	GHz	13.7	15.2	GHz	POL V

The main test steps of Part B (to be performed on June 11 and June 12) are:

1. Operate TTCB and conduct EMC/EMI test
2. Perform pre-test Health check (see sheets) TTCE-A & TTCE-B
3. Perform Spike 1 Test
    a. TTCE-A
        i. Pump operation test 3500 rpm & FAC on automatic control
        ii. Pump operation 6000 rpm & TEC on (10% duty cycle)
        iii. Pump operation 10,000 rpm & FAC on automatic control
        iv. Perform health check on Pt1000's and DS during all operation (logged)
    b. TTCE-B
        i. Pump operation test 3500 rpm & FAC on automatic control
        ii. Pump operation 6000 rpm & TEC on (10% duty cycle)
        iii. Pump operation 10,000 rpm & FAC on automatic control
    c. Perform health check on Pt1000's and DS during all operation (logged)
4. Perform Spike 2 Test
    a. TTCE-B
        i. Pump operation test 3500 rpm & FAC on automatic control
        ii. Pump operation 6000 rpm & TEC on (10% duty cycle)
        iii. Pump operation 10,000 rpm & FAC on automatic control
        iv. Perform health check on Pt1000's and DS during all operation (logged)
    b. TTCE-A
        i. Pump operation test 3500 rpm & FAC on automatic control
        ii. Pump operation 6000 rpm & TEC on (10% duty cycle)
        iii. Pump operation 10,000 rpm & FAC on automatic control
    c. Perform health check on Pt1000's and DS during all operation (logged)
5. Perform test G
6. Perform test H (Hor) (after anomaly highest rpm was lowered to 8000 rpm)
7. Perform test H (Ver)
8. .....
9. Perform test O (Hor)
10. Perform test O (Ver)
11. Empty TTCB
12. Disconnect TTCB from TCCE
13. Transport TTCE to TV-chamber for TTCB-S TV testing

All tests were done for TTCE-A and TTCE-B in order ABBAABBAABB etc.

6 Test facility/equipment description

The test is performed at SERMS (Terni) at the EMC/EMI test facility and the following type of equipment will be used for operating the TTCB:

- TTCE / cables / CAN-if / pc with TTCE sw
- CO2
- Mass flow meter
- Absolute transducer
- Differential pressure transducer
- Temperature sensors, TC type T
- NI cDAQ system
- Pc with LV sw
- Thermostat bath for cooling CO2 (GSE-loop)

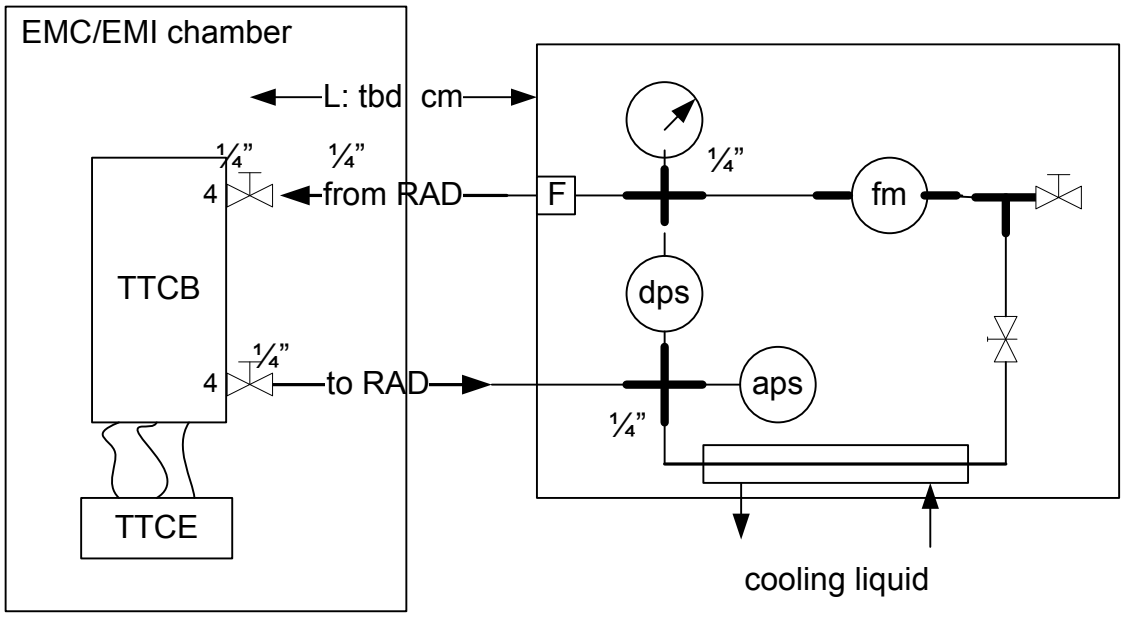


Figure 6-1: schematic with GSE for operating TTCB

As the EMI/EMC air conditioners could not keep the temperature below 20 °C. Therefore the TTCB box is put in a plastic temperature controlled volume inside the EMI/EMC chamber. This to provide a temperature below 20 °C during testing (by a portable air conditioner). Apart from the EMI testing the portable air conditioner could be used during all tests.

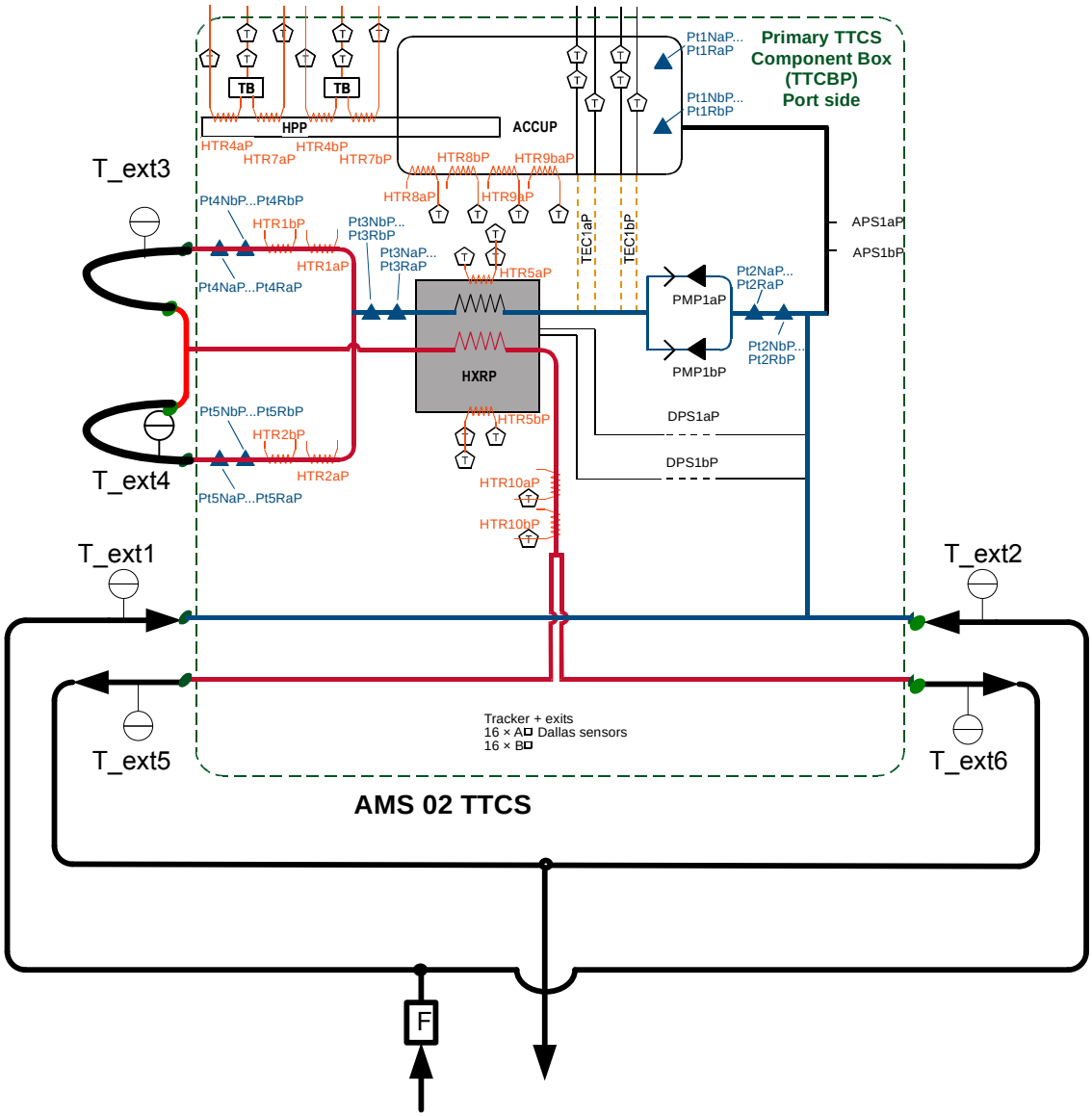


Figure 6-2: TTCB schematic with additional tubing for functional test

6.1 TTCB Safety

To avoid over pressurising of the TTCB and moreover the valves and the connectors a safety relief valve is put in the system. This safety relieve valve will open at 69 bar which is approximately a CO2 two-phase saturation temperature of +29 ºC. During the night the air conditioners of the EMI chamber were put al full power to keep the TTCB below +29 ºC.

6.2 Test set-up picture

In the below pictures the test set-up is shown.

Figure 6-3: Air conditioned set-up in the CEM EMC chamber (table grounding)

Figure 6-4: Air conditioned set-up in the CEM EMC chamber (cabling connection)

Figure 6-5: Air conditioned set-up in the CEM EMC chamber (TTCE next to TTCB)

Figure 6-6: Cooling loop set-up outside the chamber

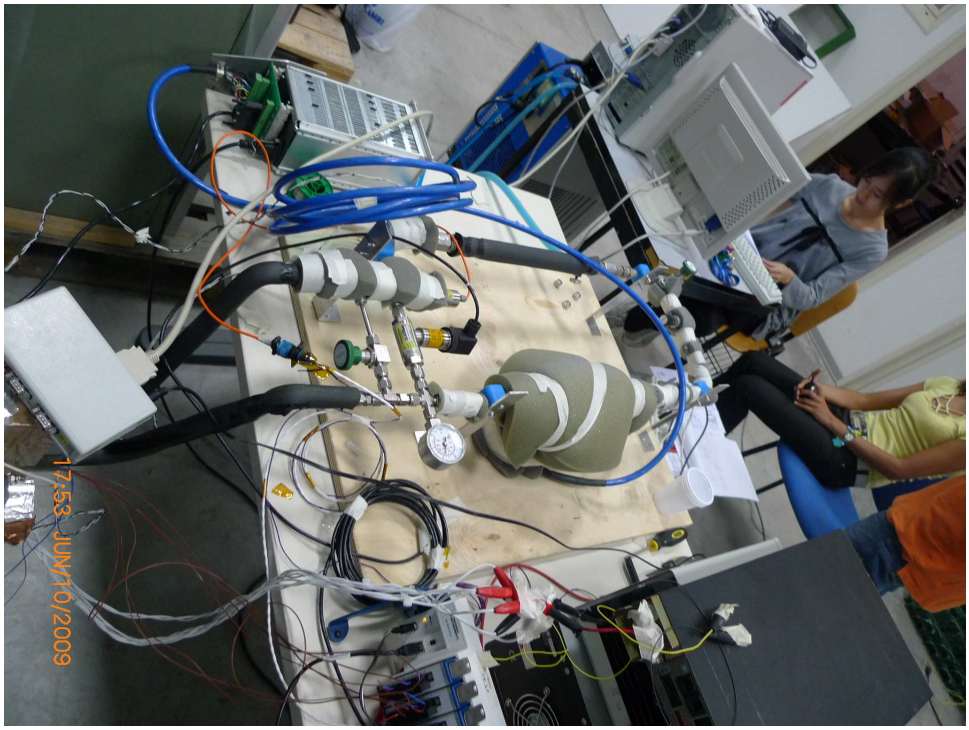


Figure 6-7: Cooling loop set-up outside the chamber detail

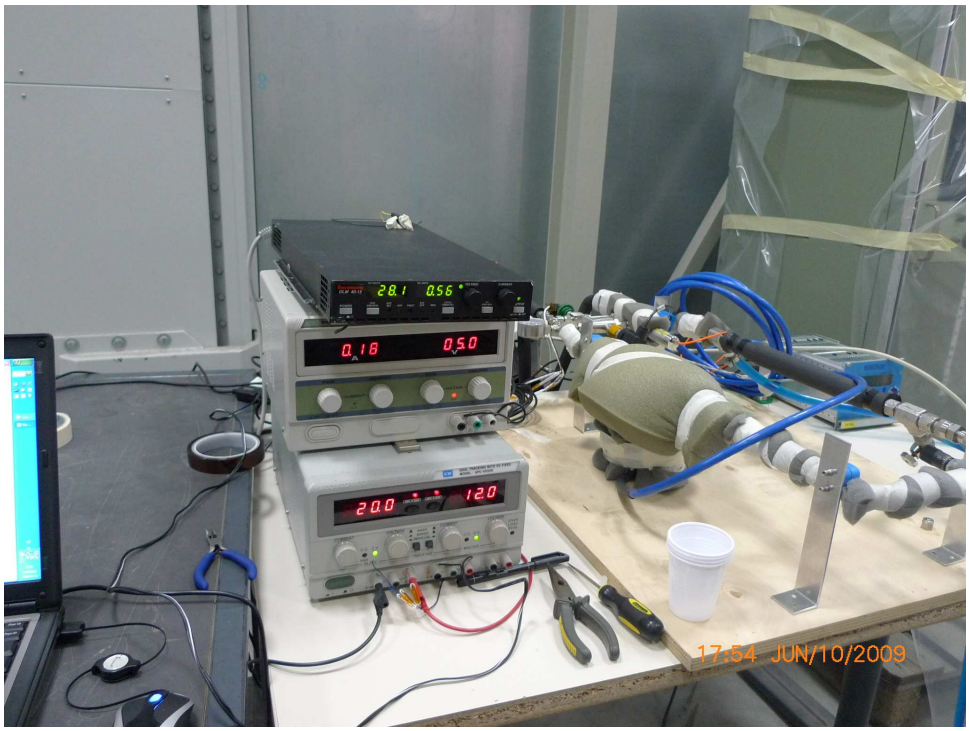


Figure 6-8: Power supply set-up outside the chamber during test run

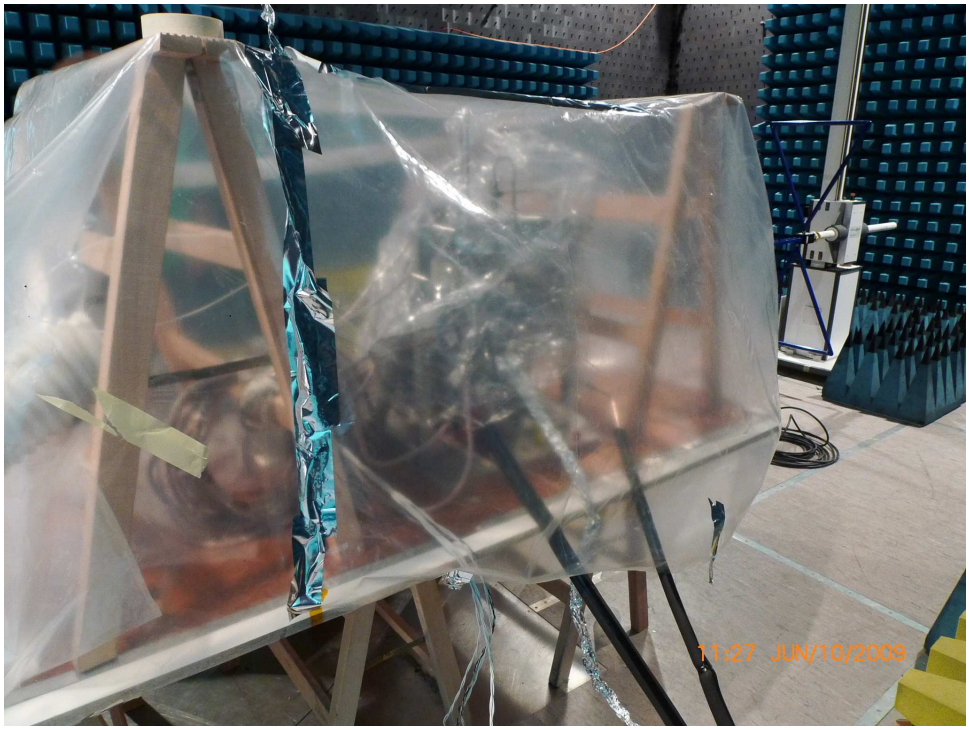


Figure 6-9: Detail front side TTCB-P test set-up

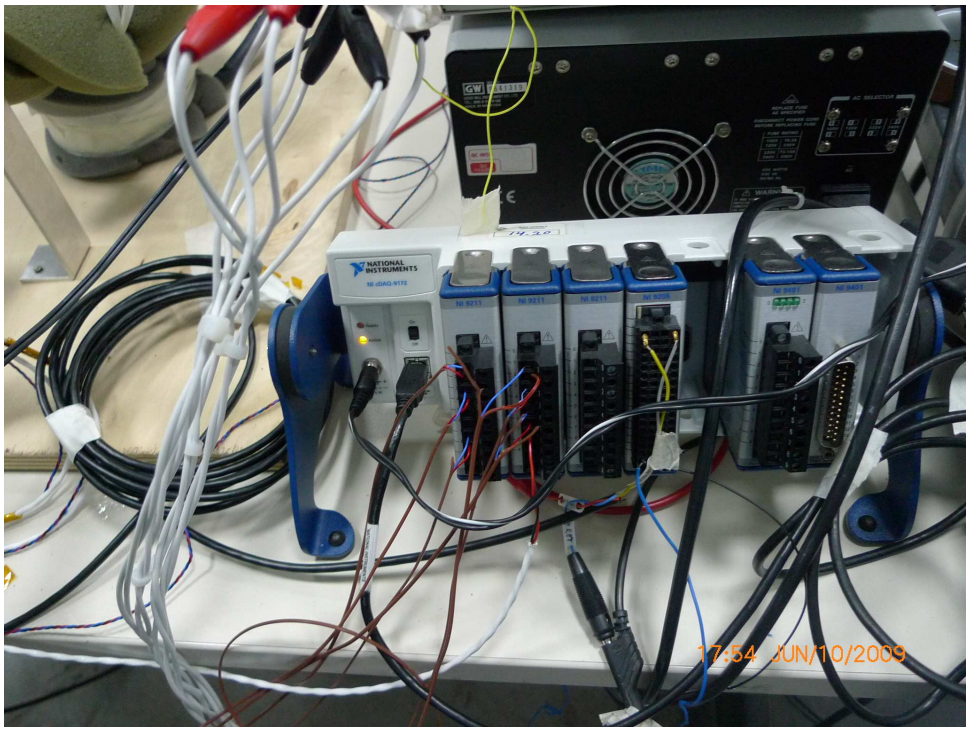


Figure 6-10: NI DAC system detail

Figure 6-11: Item under test TTCB-P front side

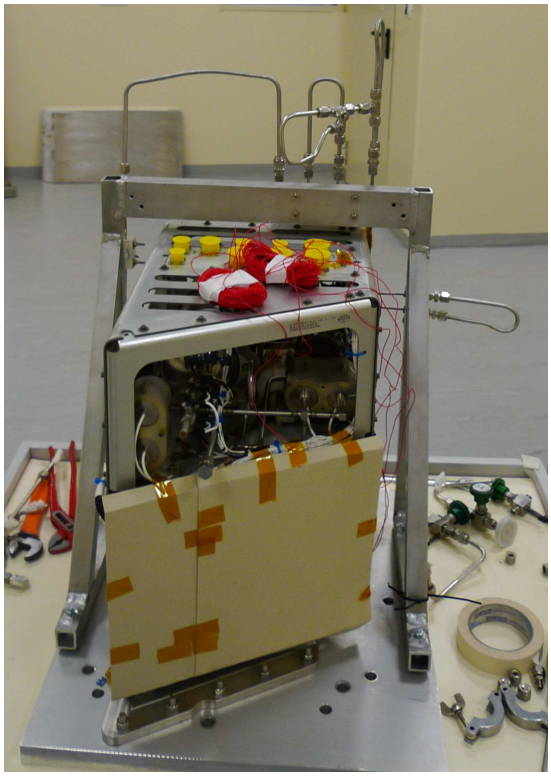


Figure 6-12: Item under test TTCB-P back side

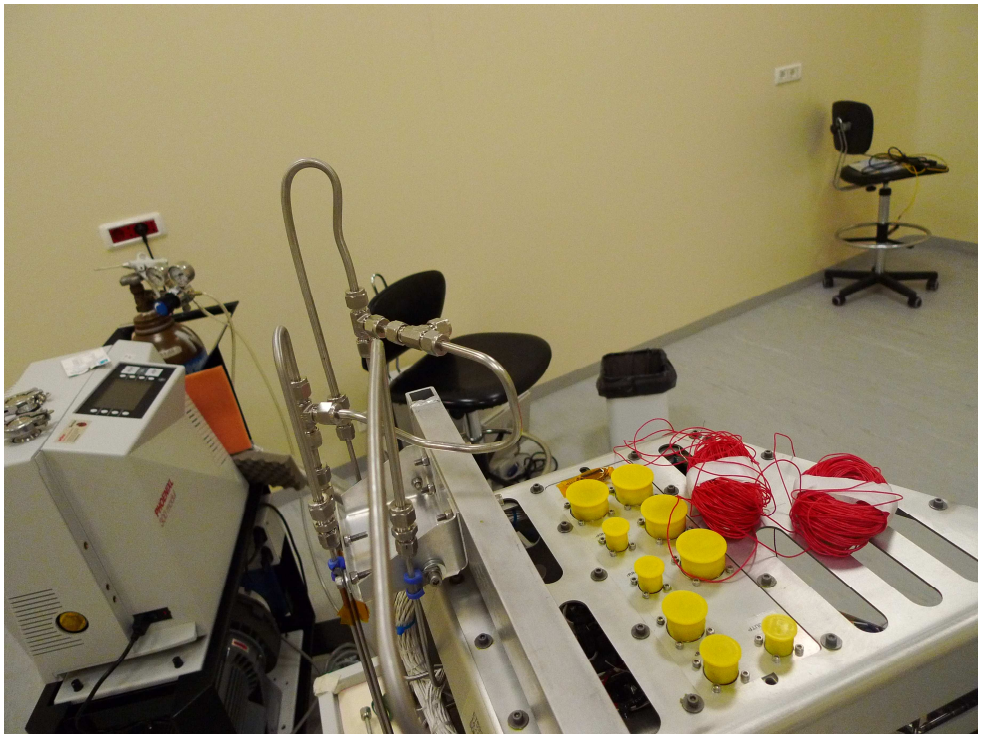


Figure 6-13: Item under test TTCB-P connectors

7 Part A: EMI radiation emission results

All the TTCB components showed to fulfil the EMI test requirements.

Test Abbrevation	Test name and Frequency range				
	Day 1	2009-06-10			
	Radiated Emission Test			**14 KHz**	**15.5 GHz**
A	KHz	14	150	KHz	
B	KHz	150	30	MHz	
C (Hor)	MHz	30	300	MHz	POL H
C (Ver)	MHz	30	300	MHz	POL V
D (Hor)	MHz	300	700	MHz	POL H
D (Ver)	MHz	300	700	MHz	POL V
E (Hor)	GHz	700	1	GHz	POL H
E (Ver)	GHz	700	1	GHz	POL V
F (Hor)	GHz	1	15.5	GHz	POL H
F (Ver)	GHz	1	15.5	GHz	POL V

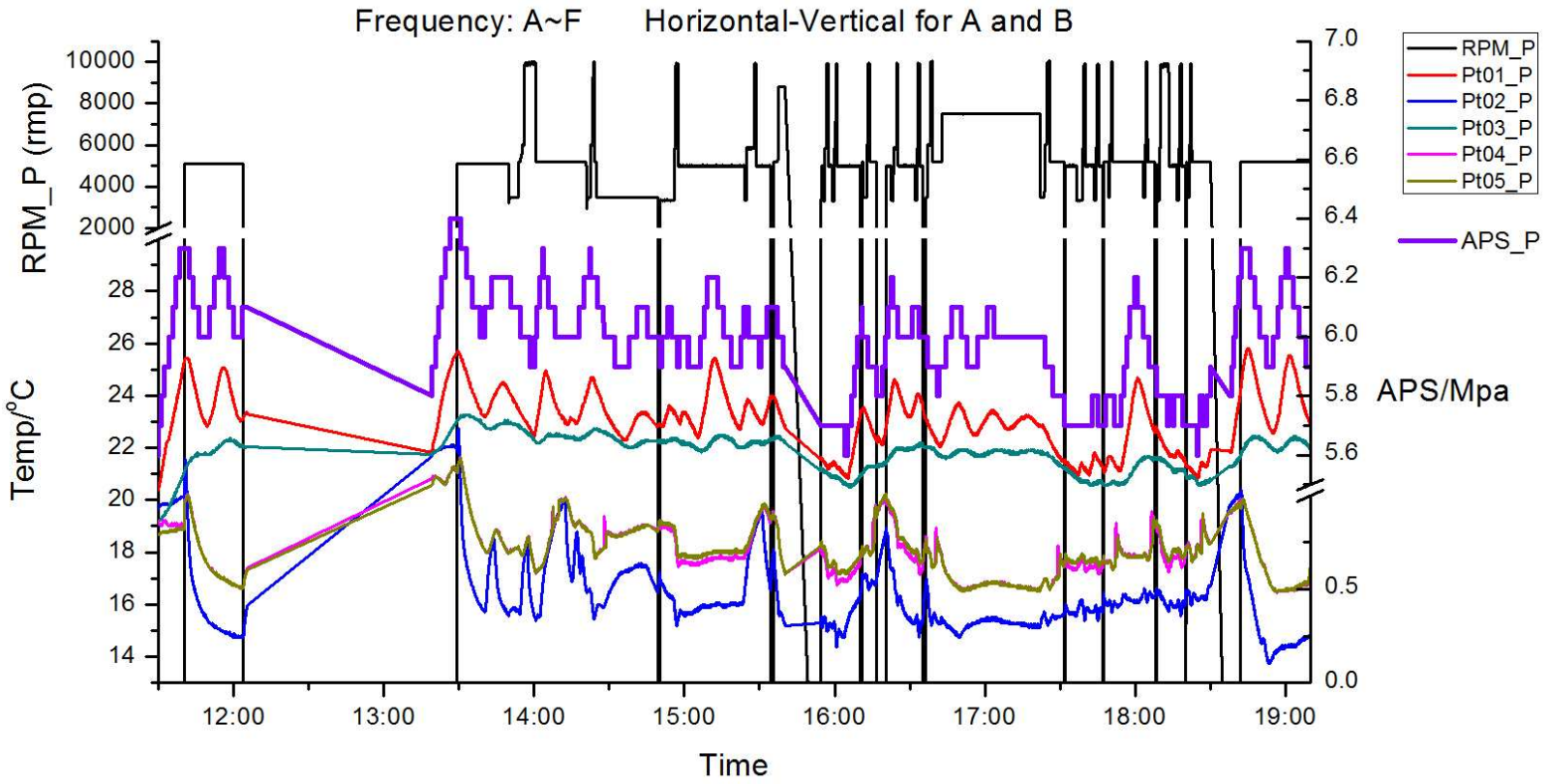
The induced filed are shown in RD-3 (TBC).

All the below shown actuators induced fields are checked in for the separate frequencies.

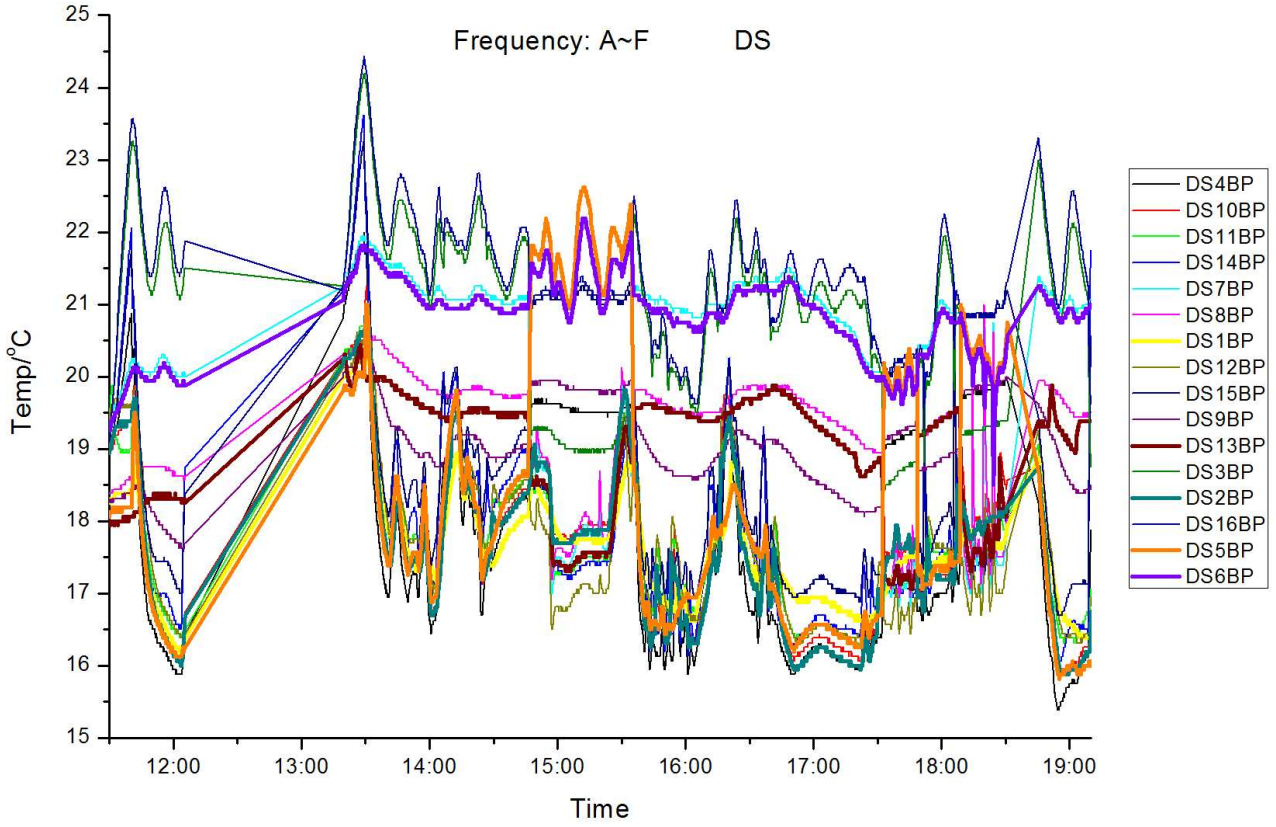
	Actuator	Pump running	comment
1	Peltier elements	no	PWM, 10 %
2	Accumulator heater FAC	no	PWM, 90 % (TBC)
3	TTCB pump	yes	3500, 6000, 10000 RPM
4	Pre-heater	yes (normal flow)	Manual ON during complete EMI test duration
5	Start Up Heater	yes (normal flow)	Manual ON during complete EMI test duration
6	Cold Orbit Heater	yes (normal flow)	Manual ON during complete EMI test duration

The function check test results are shown in below figures.

7.1 Frequency: A~F Test results



PT1000, Pump speed and APS



Dallas sensors

8 Part B: EMC Test results

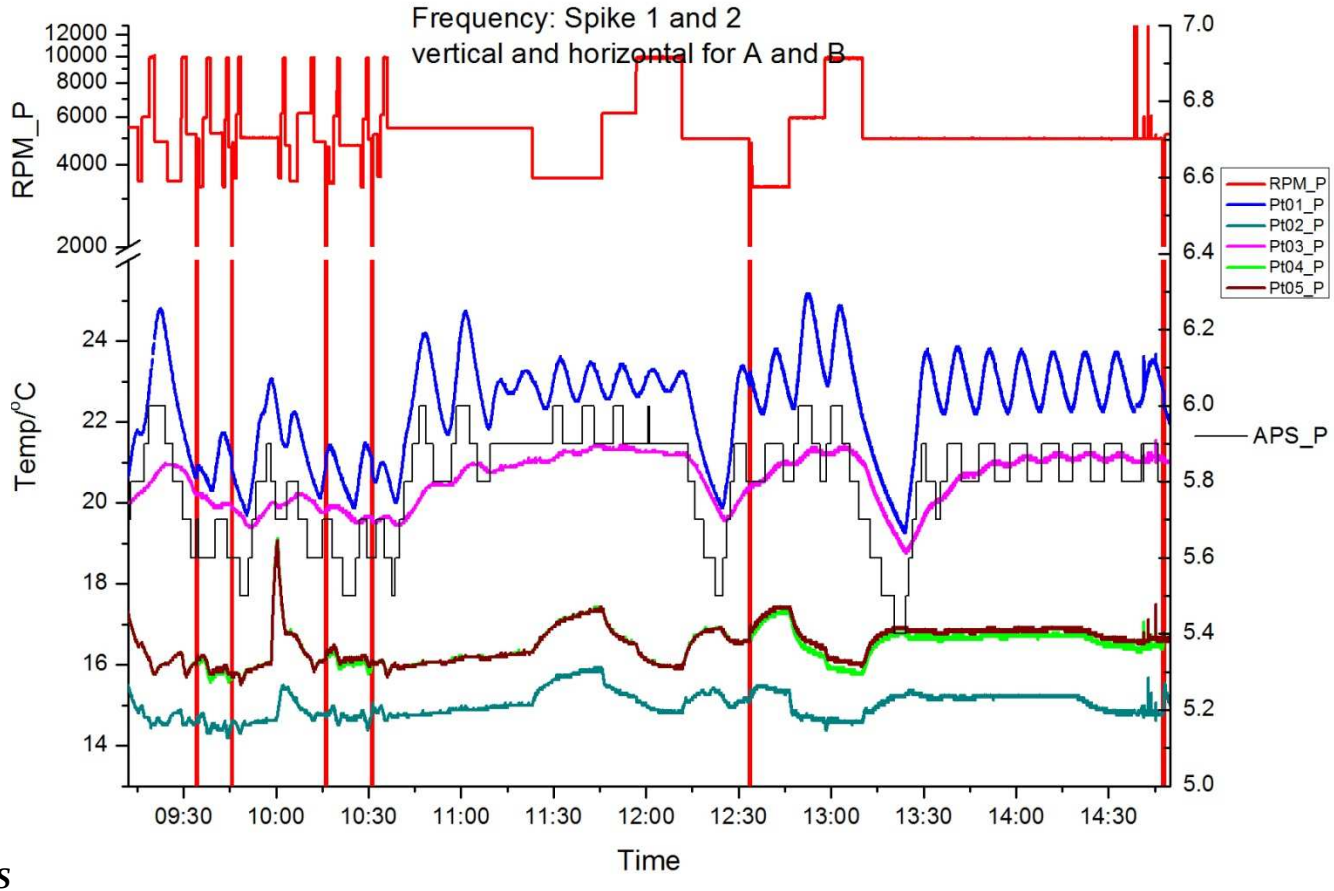
In the below section he (functional) test results during the EMC field testing are shown. Only in the horizontal and vertical H-field (200 mHz-1 GHz) anomalies were found in the TTCB/TTCE operation and communication. In the rest of the fields the TTCB/TTCE operated without any problems.

Day 2 2009-06-11

	Radiated Spikes		**(RS-02)**		
				minutes	# TTCB CONF
Spike 1	pulses		10 micro	1	13
Spike 2			150 nano	1	13

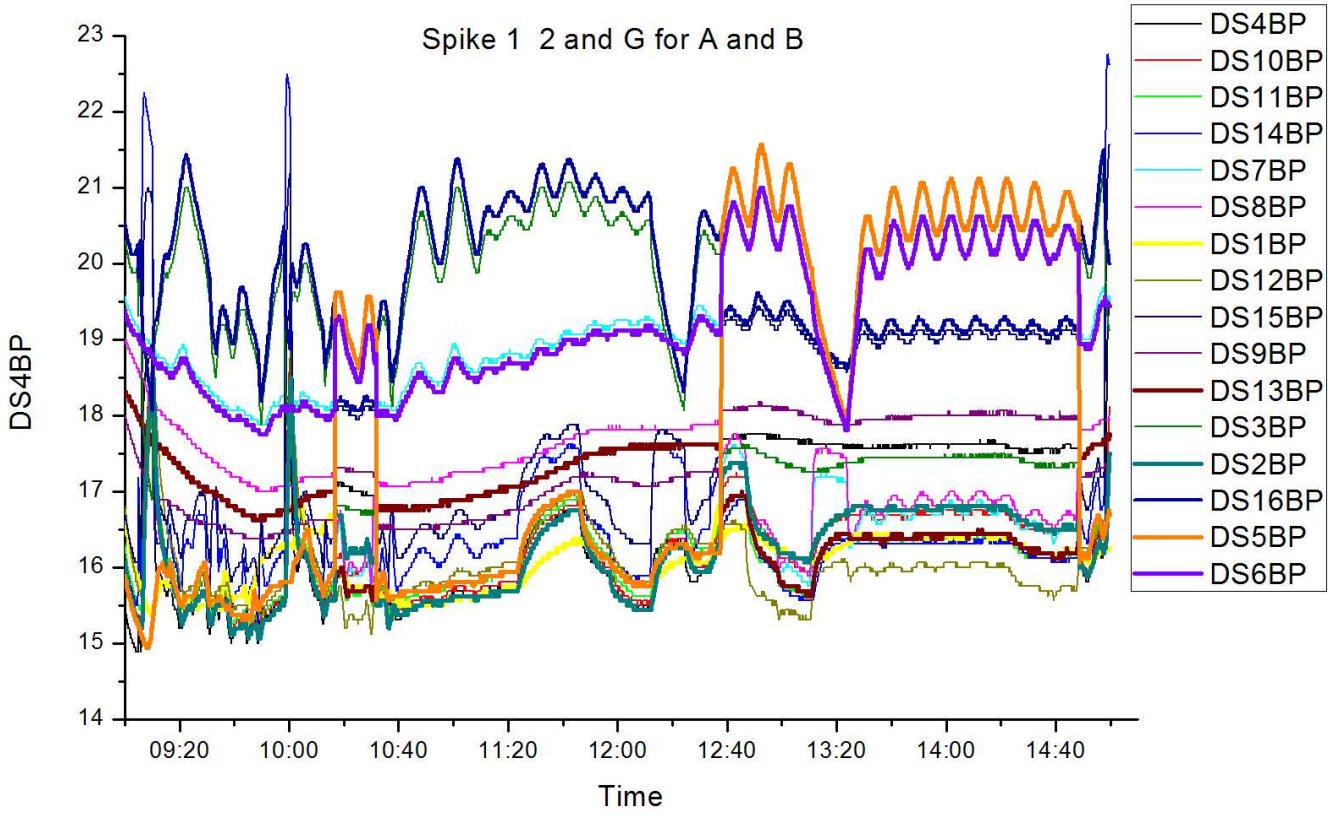
	Radiated	Electric field level		(RS03)	
G	Khz	14	10	Mhz	
H (Hor)	MHz	**200**	**1**	GHz	POL H
H (Ver)	MHz	**200**	**1**	GHz	POL V
I (Hor)	GHz	1	2	GHz	POL H
I (Ver)	GHz	1	2	GHz	POL V
J (Hor)	GHz	**2**	**4**	GHz	POL H
J (Ver)	GHz	**2**	**4**	GHz	POL V
K (Hor)	GHz	4	8	GHz	POL H
K (Ver)	GHz	4	8	GHz	POL V
L (Hor)	GHz	**8**	**10**	GHz	POL H
L (Ver)	GHz	**8**	**10**	GHz	POL V
M (Hor)	GHz	2.2		GHz	POL H
M (Ver)	GHz	2.2		GHz	POL V
N (Hor)	**GHz**	**8.5**		GHz	POL H
N (Ver)	**GHz**	**8.5**		GHz	POL V
O (Hor)	GHz	13.7	15.2	GHz	POL H
O (Ver)	GHz	13.7	15.2	GHz	POL V

8.1 Frequency: Spike 1 , Spike 2 and G



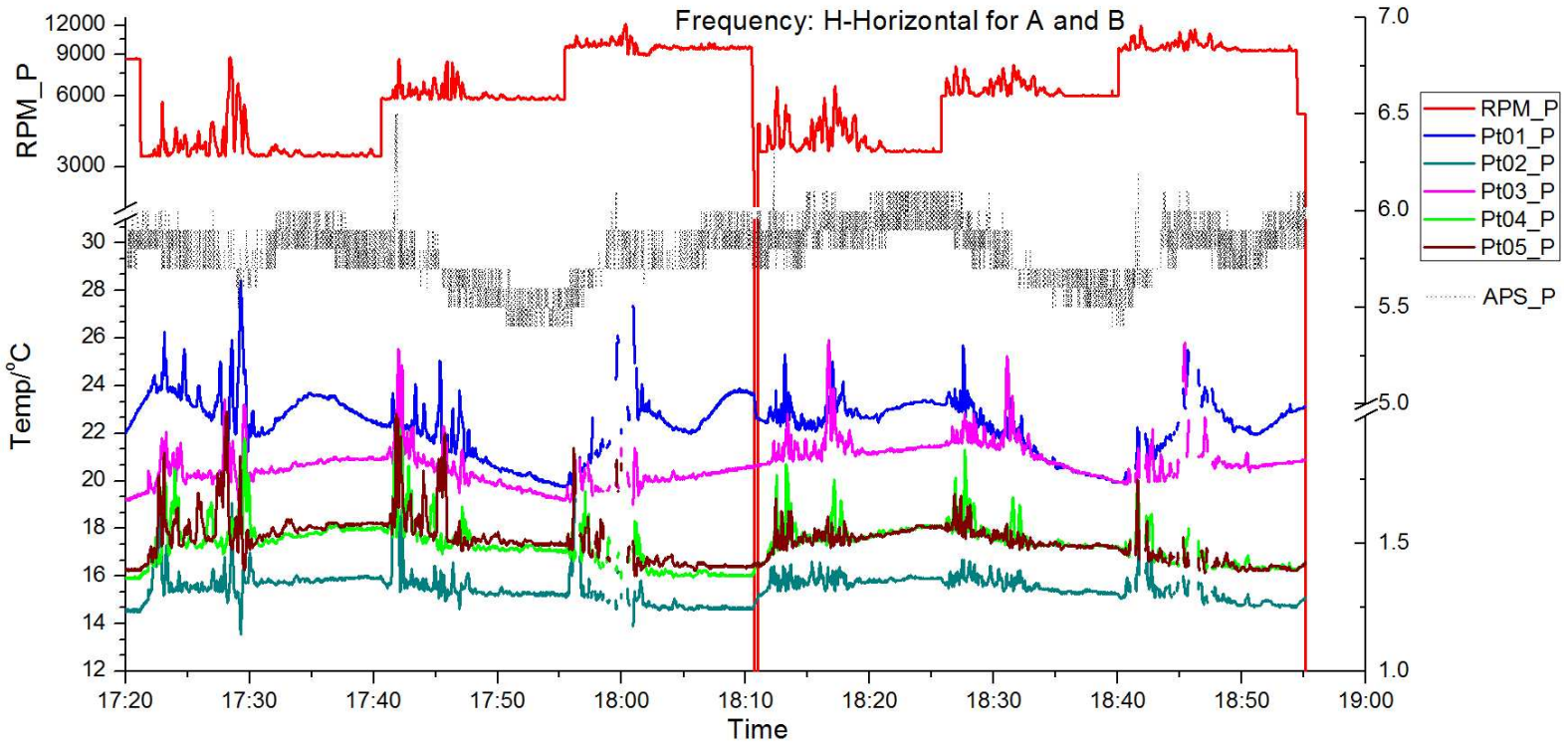
PT1000, Pump speed and APS

Dallas sensors

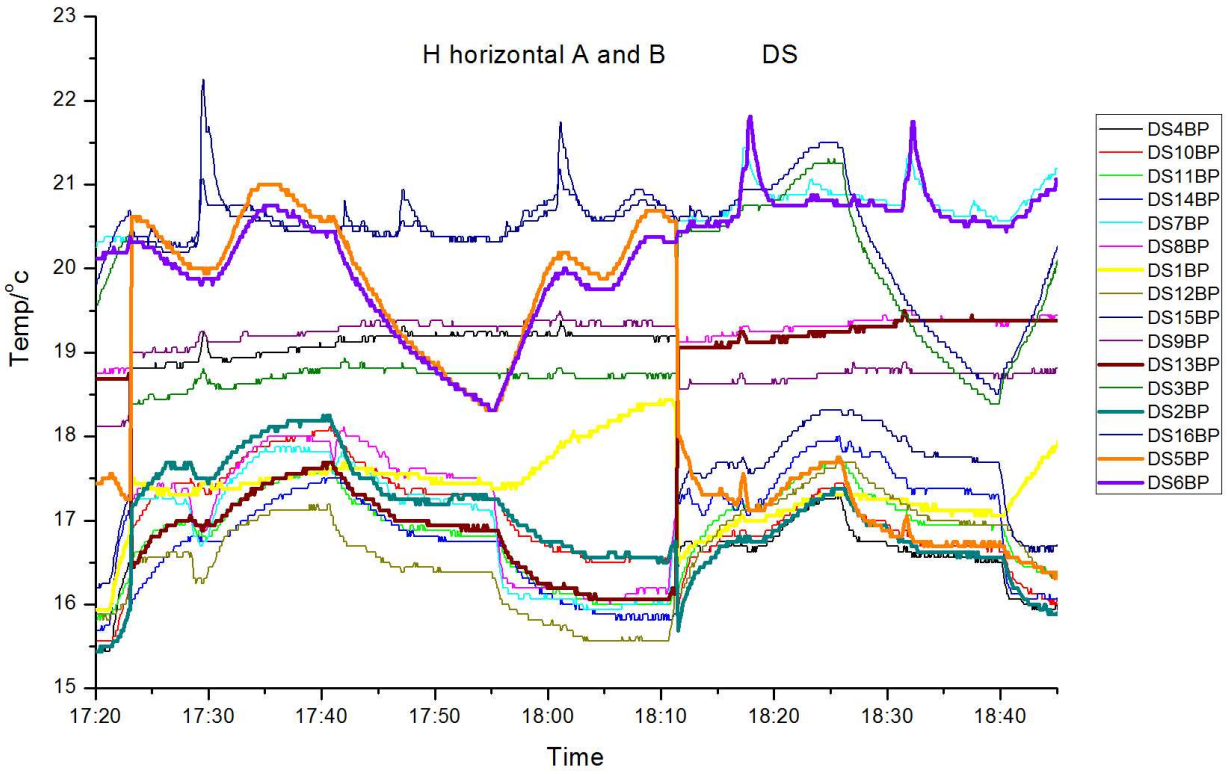


9 Frequency: H-horizontal

H-horizontal-overview

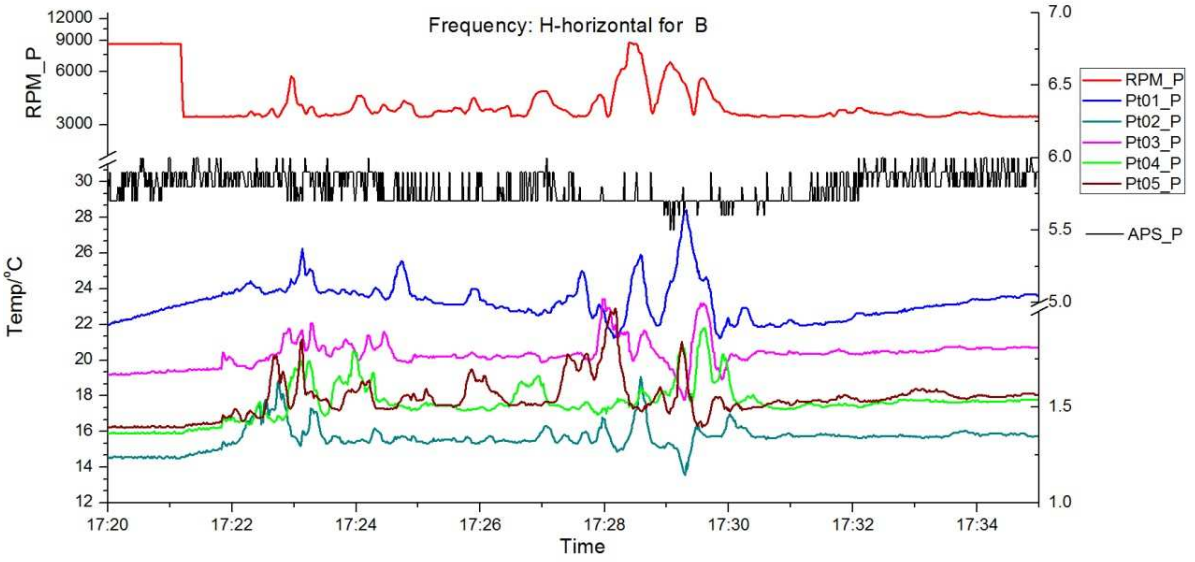


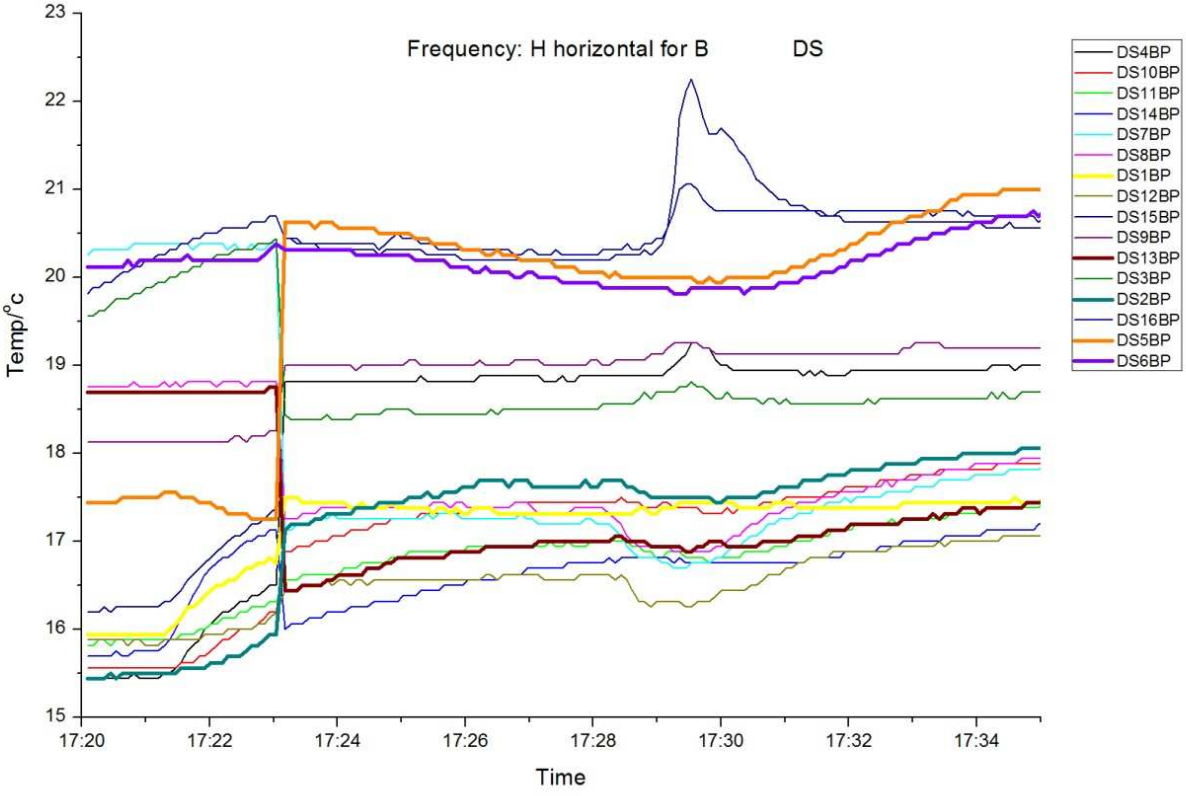
H-horizontal-overview Dallas Sensors



9.1 H-horizontal TTCE-B pump speed 3500 rpm

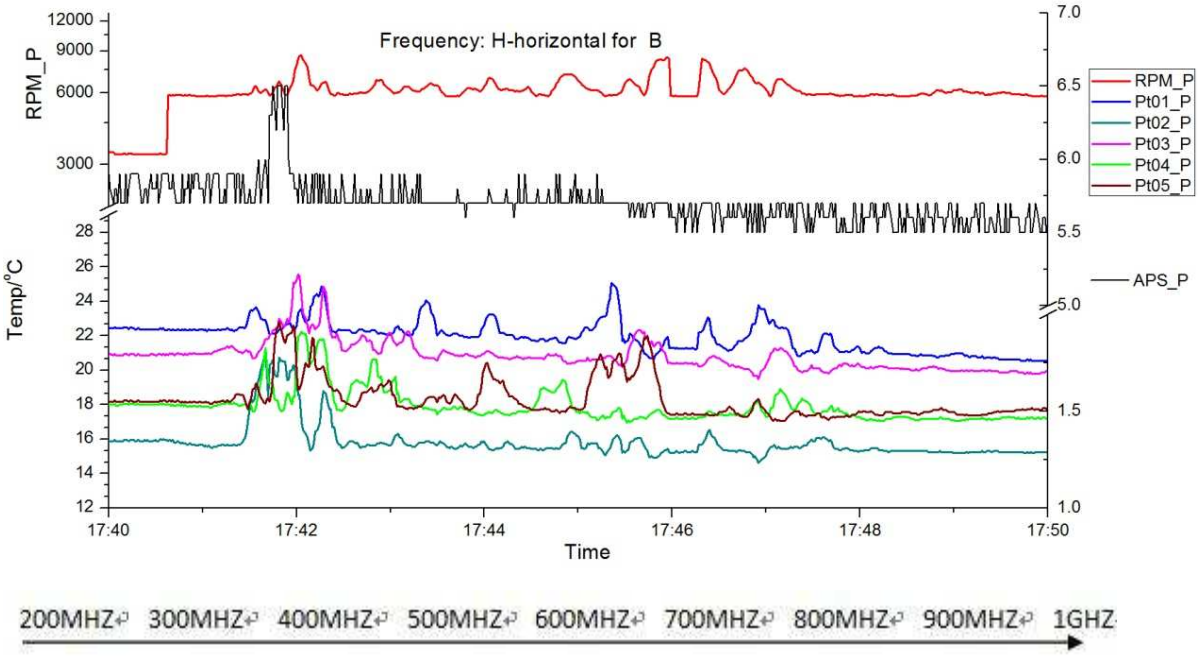
PT1000, Dallas_B, APS, RPM

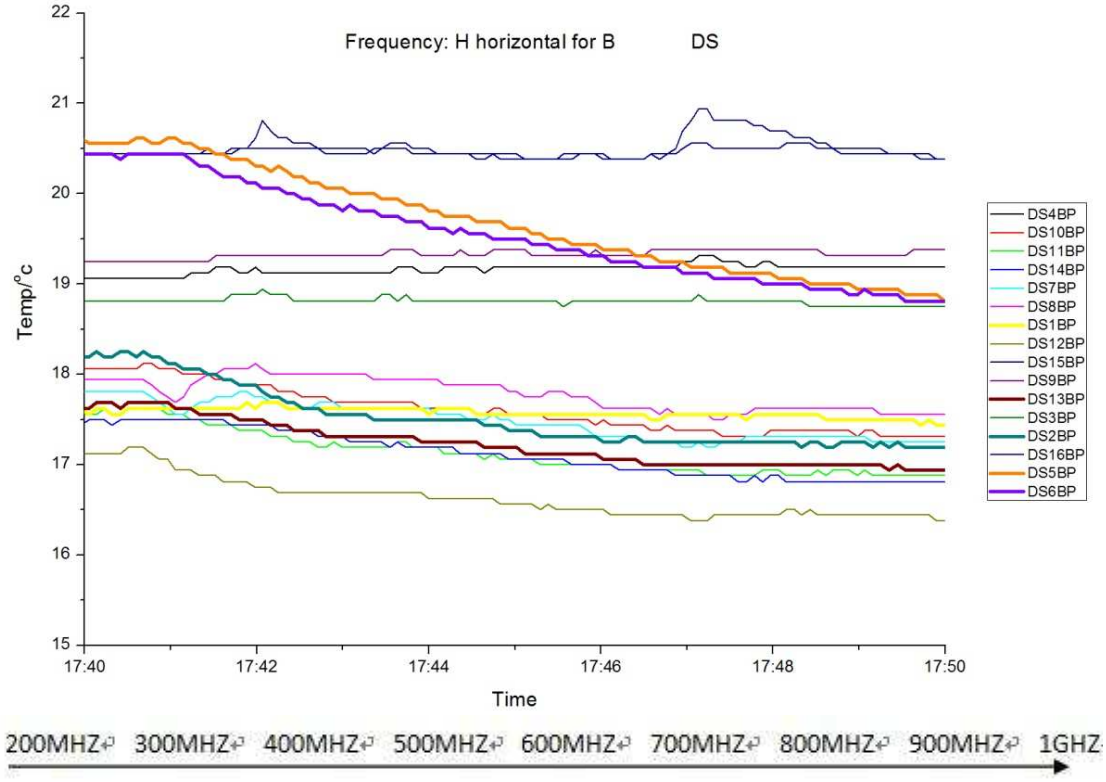




9.2 H-horizontal TTCE-B pump speed 6000 rpm

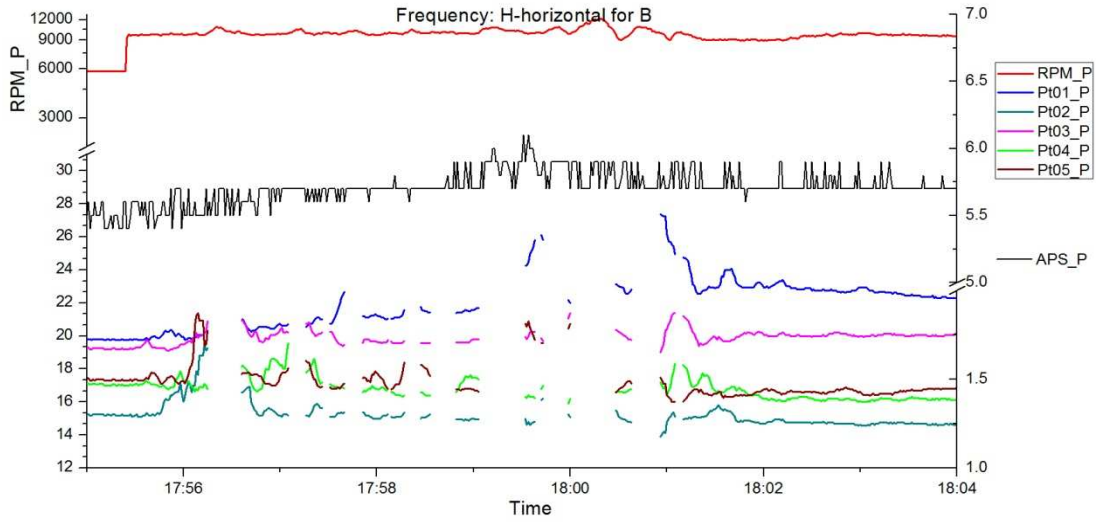
PT1000, Dallas_B, APS, RPM

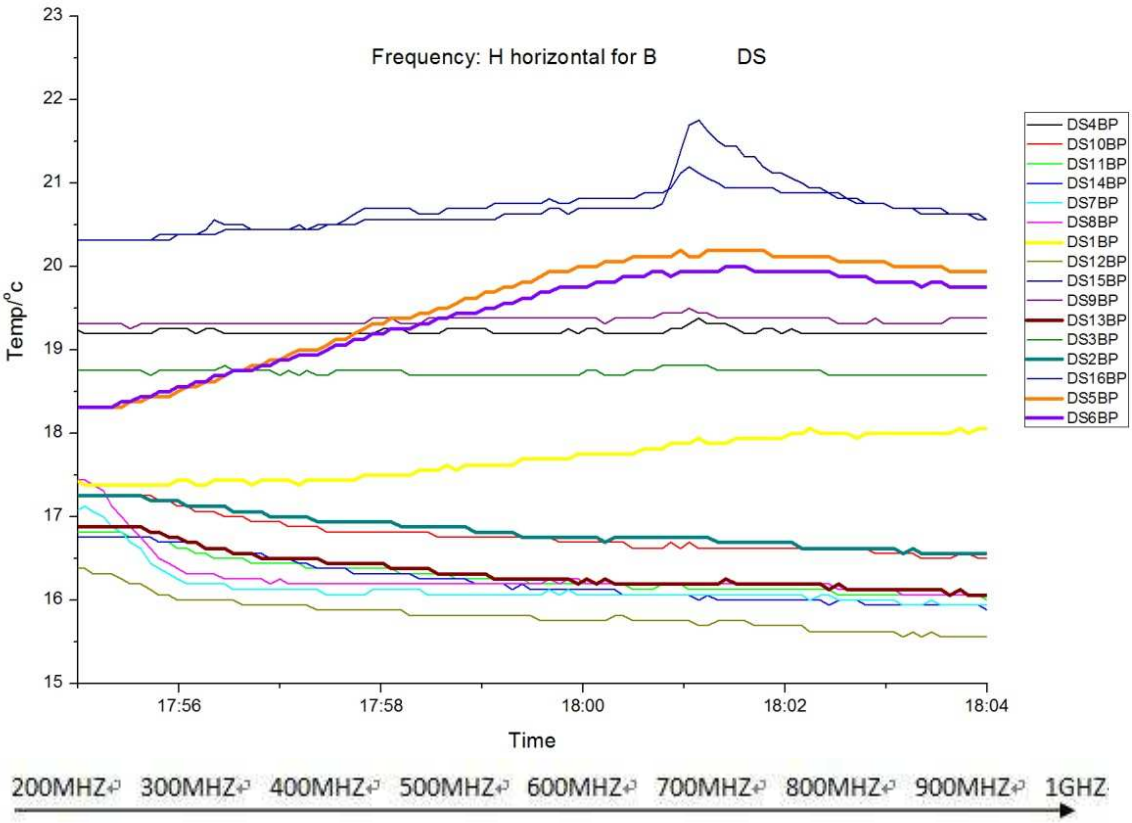




9.3 H-horizontal TTCE-B pump speed 10,000 rpm

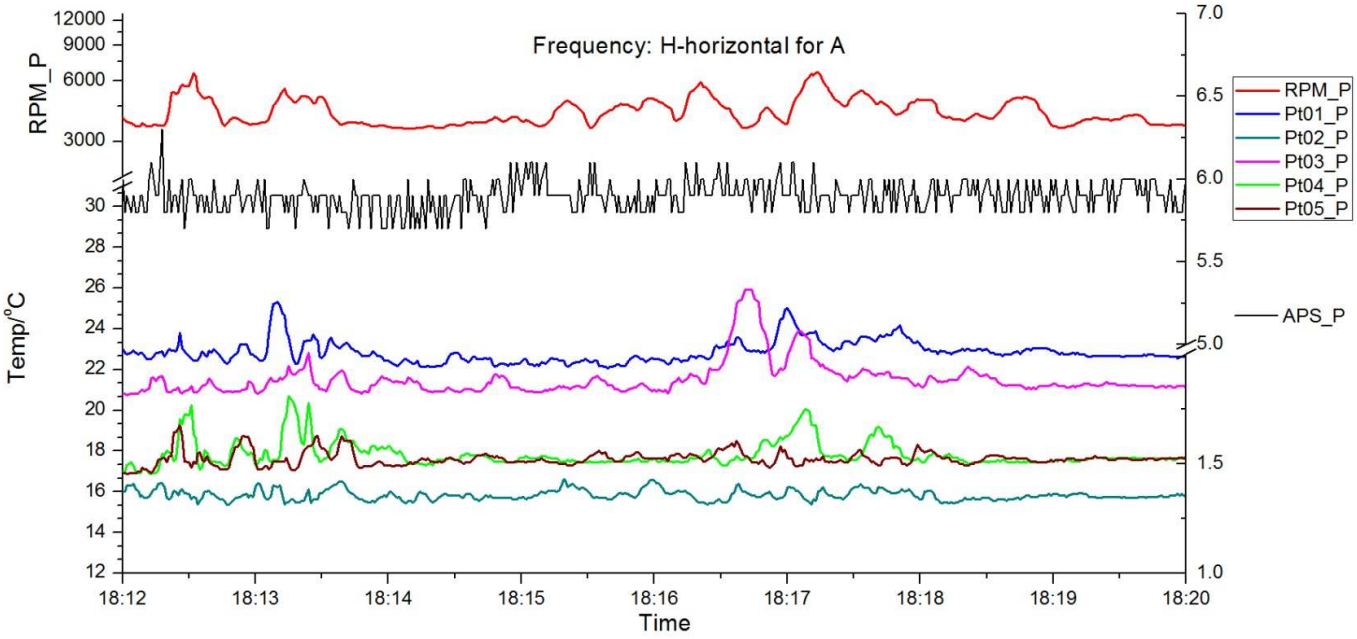
PT1000, Dallas_B, APS, RPM



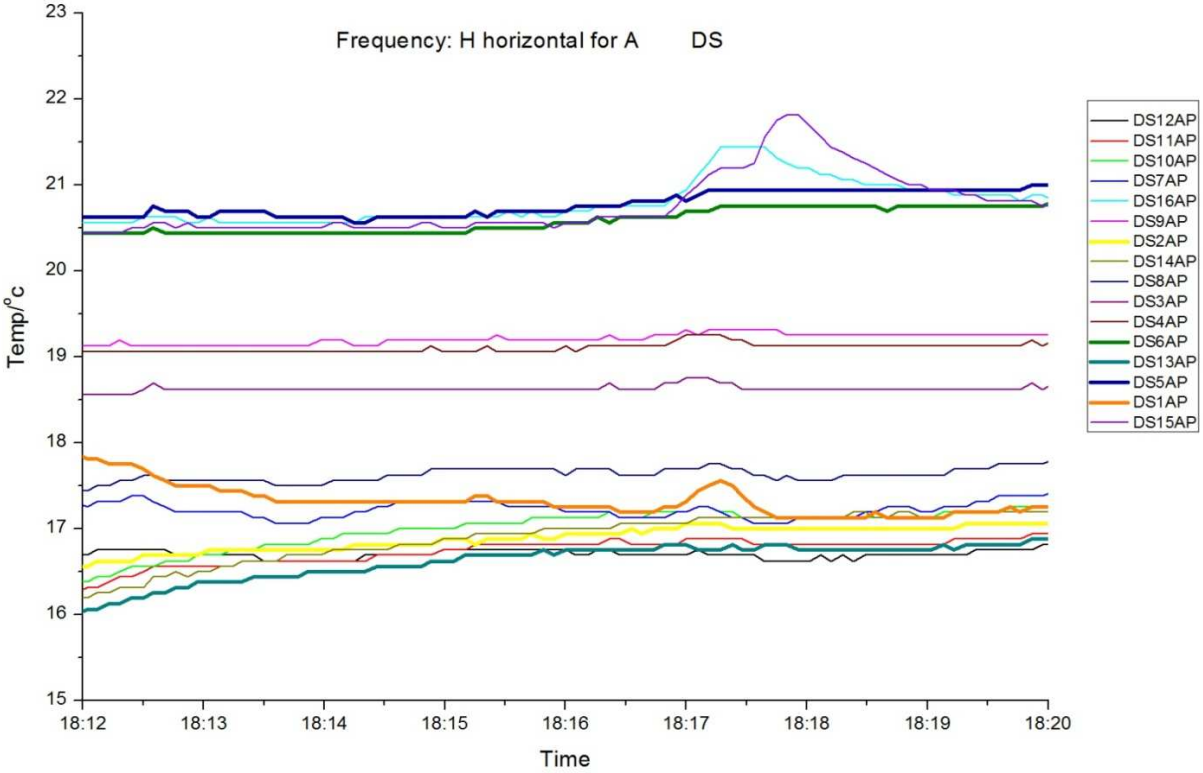


9.4 H-horizontal TTCE-A pump speed 3500 rpm

PT1000, Dallas_B, APS, RPM

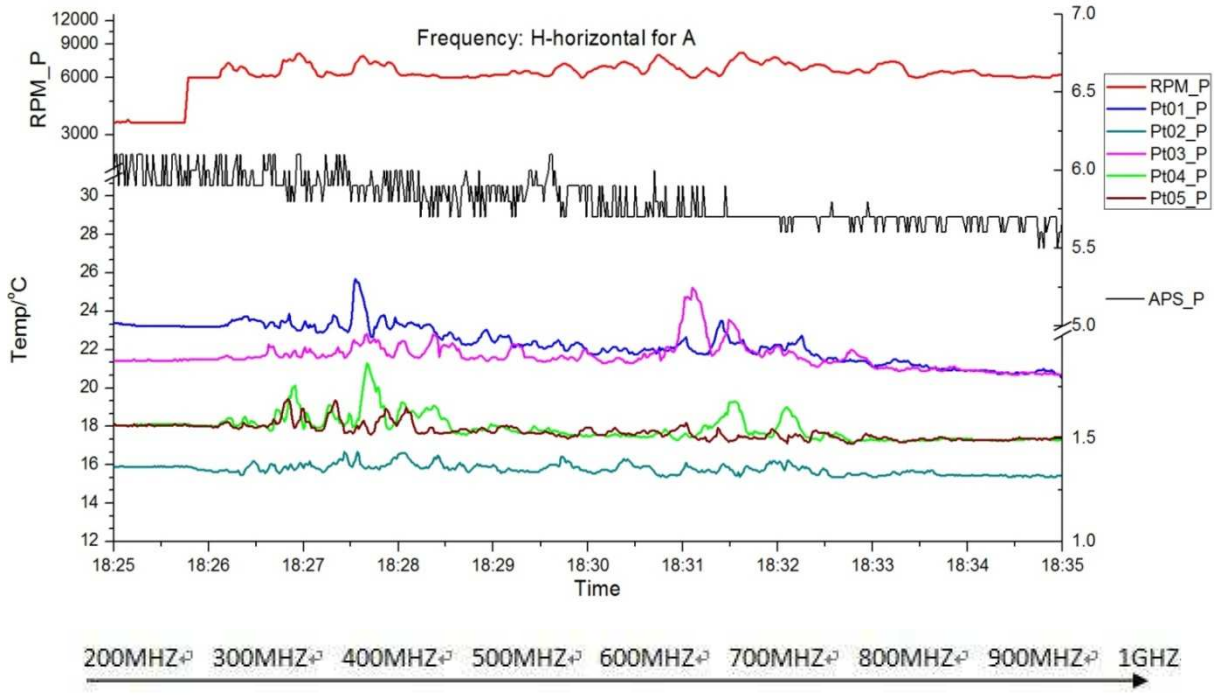


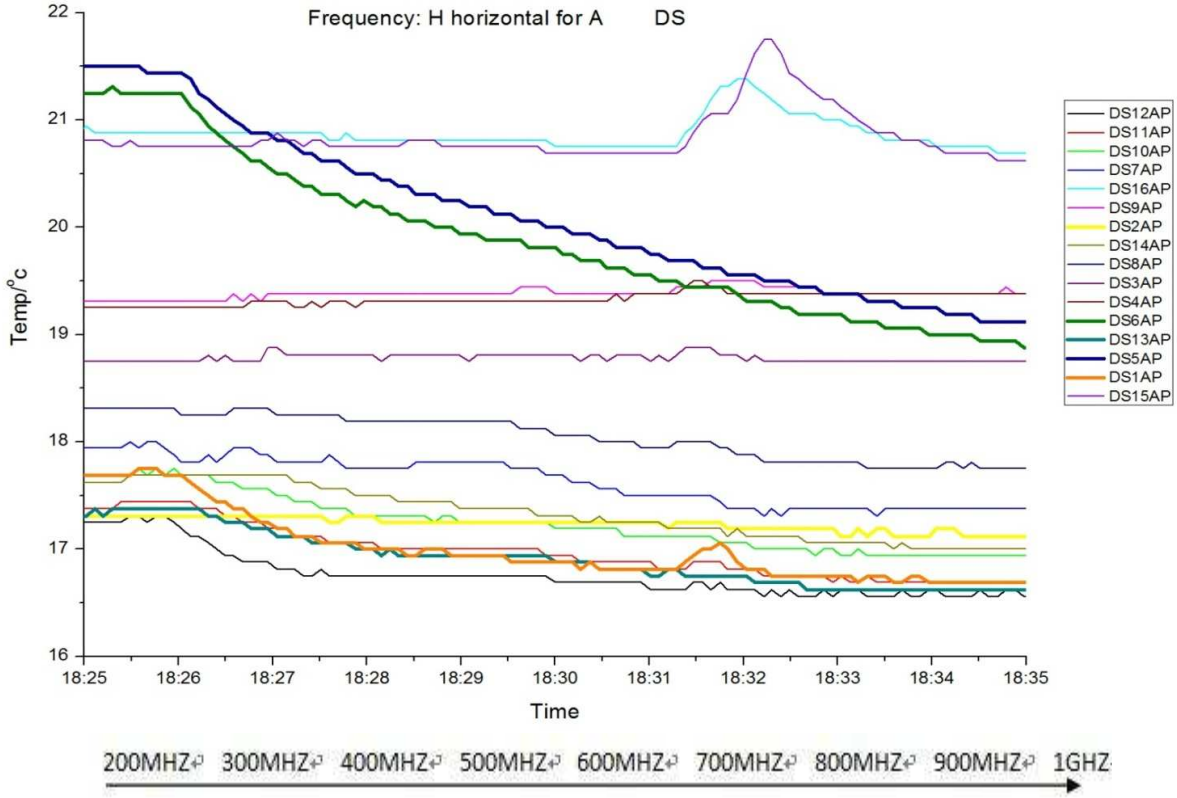
200MHZ 300MHZ 400MHZ 500MHZ 600MHZ 700MHZ 800MHZ 900MHZ 1GHZ



9.5 H-horizontal TTCE-A pump speed 6000 rpm

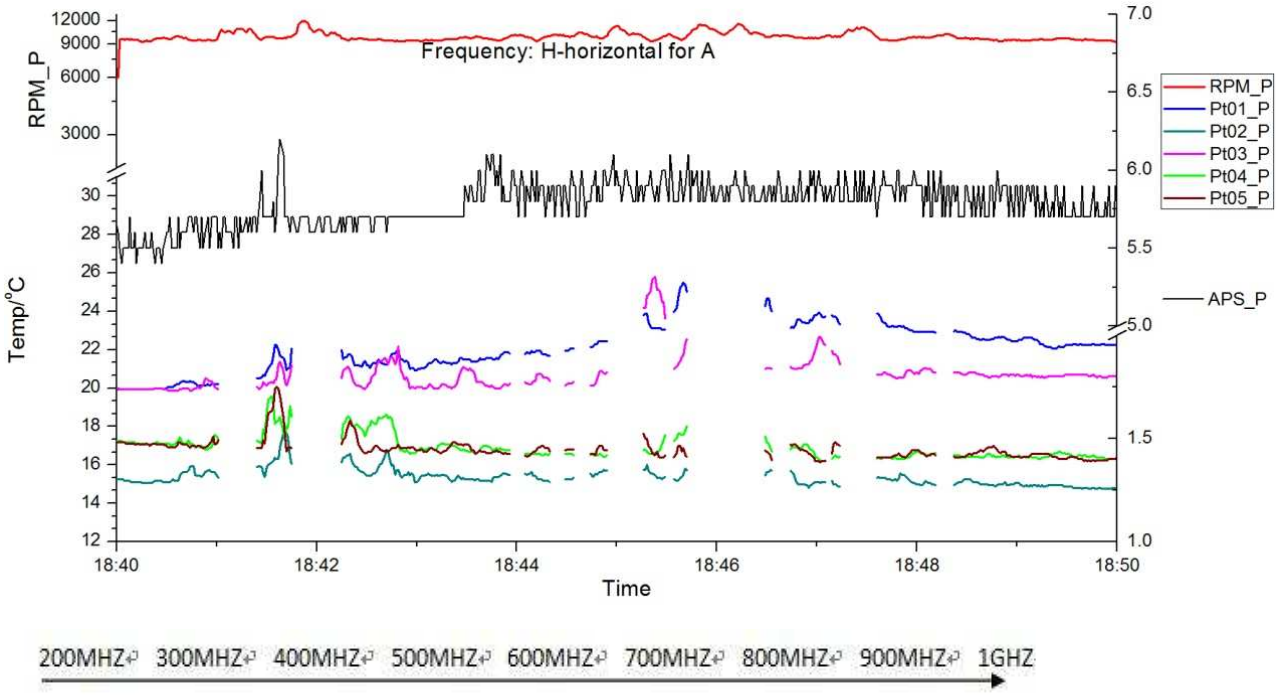
PT1000, Dallas_B, APS, RPM

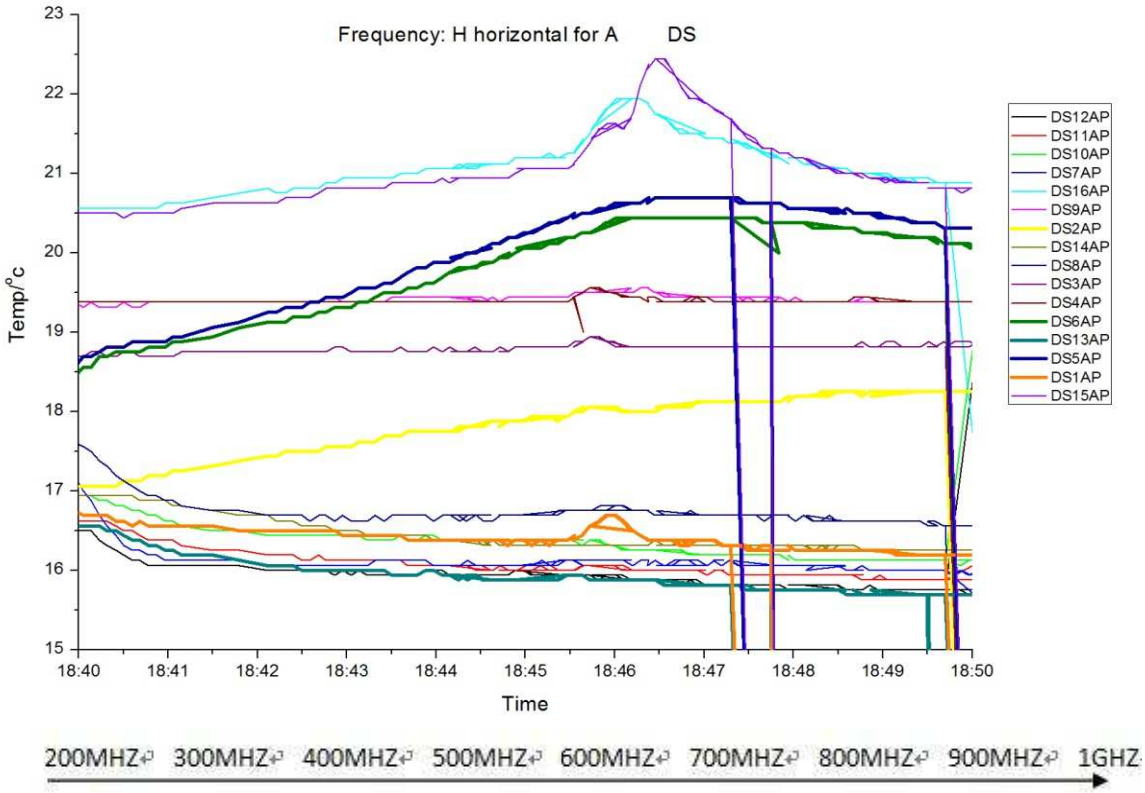




9.6 H-horizontal TTCE-A pump speed 10,000 rpm

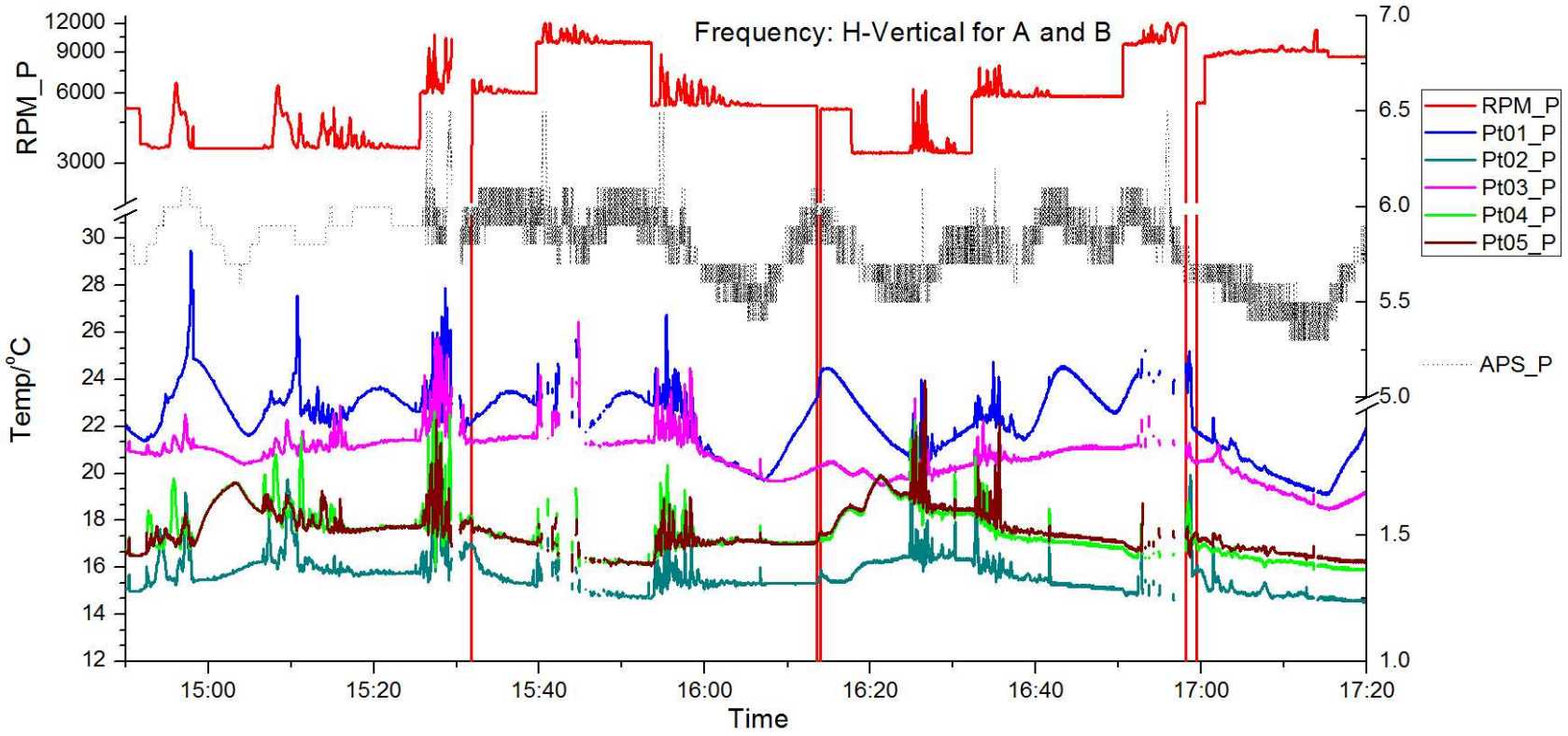
PT1000, Dallas_B, APS, RPM



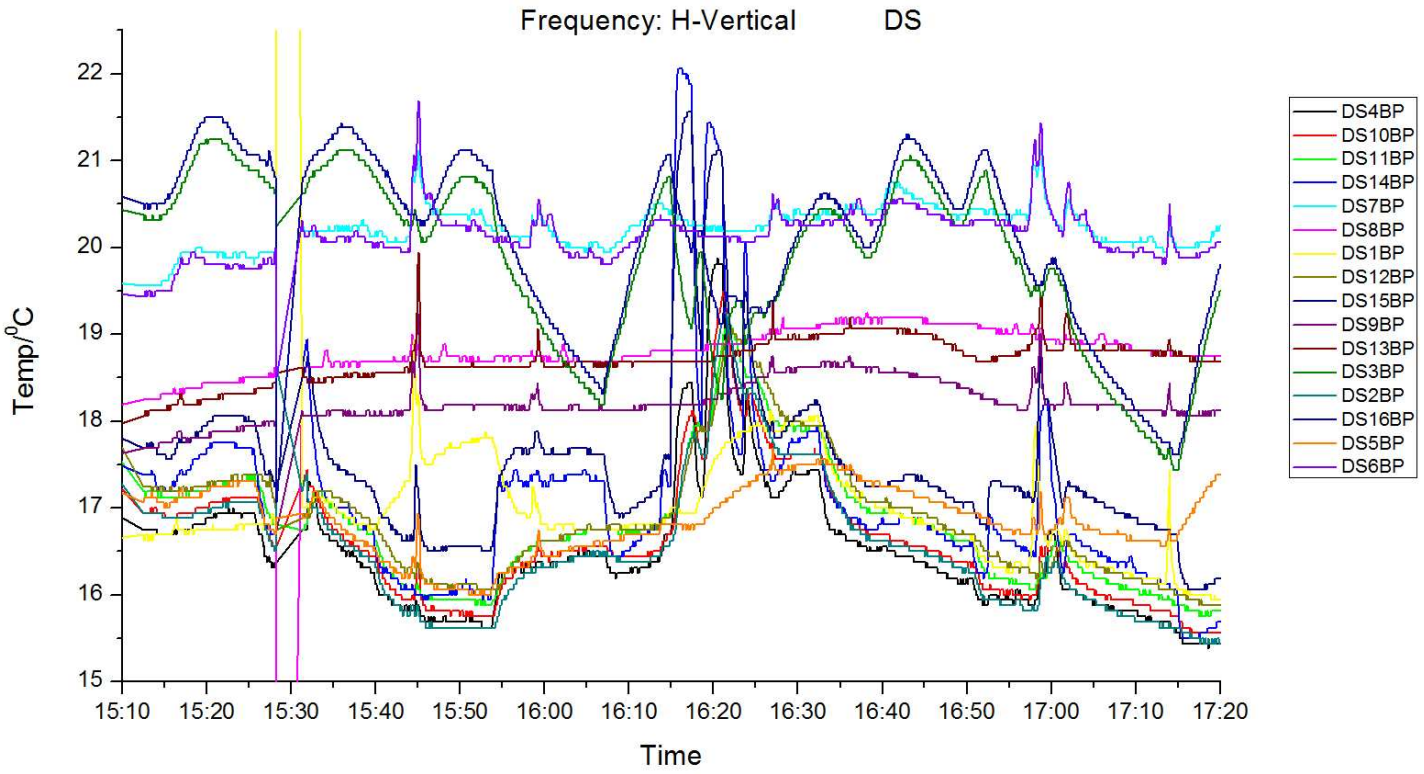


10 Frequency: H-vertical

H-vertical-overview

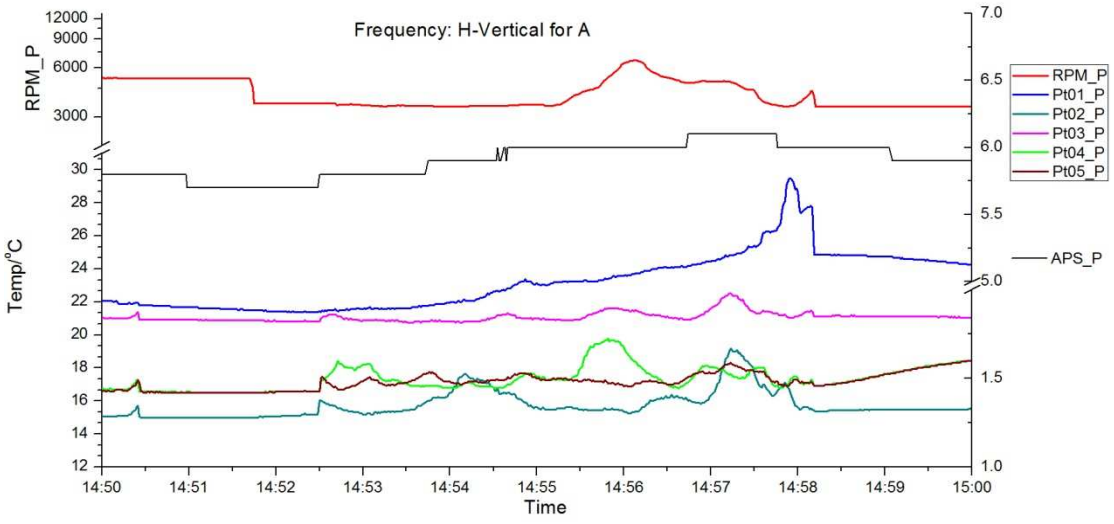


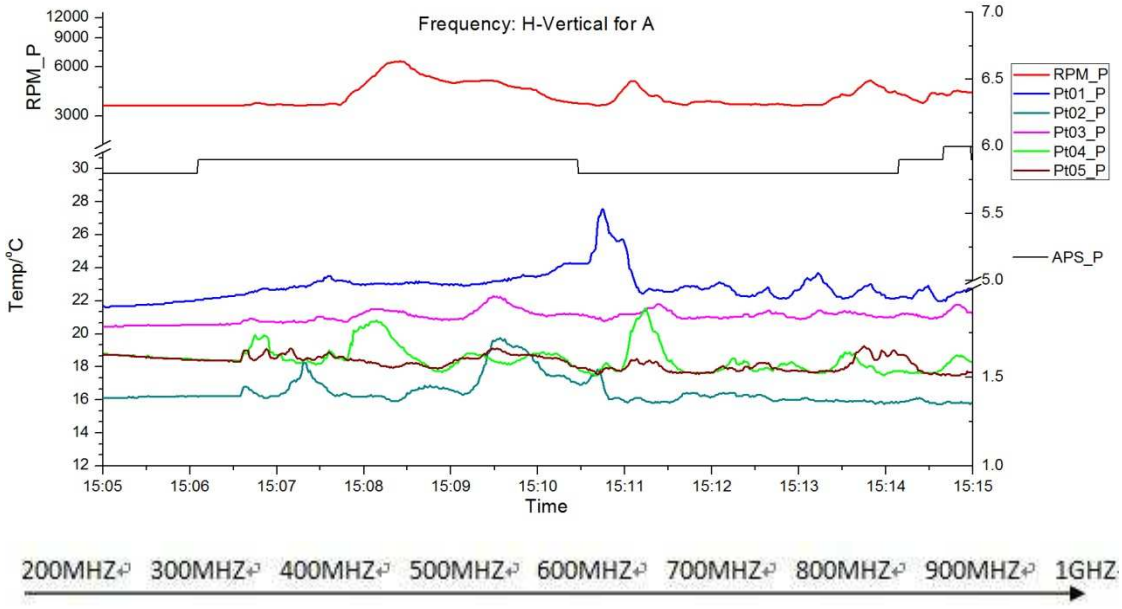
H-vertical overview Dallas Sensors



10.1 H-vertical TTCE-A pump speed 3500 rpm

PT1000, APS, RPM (repeated twice)



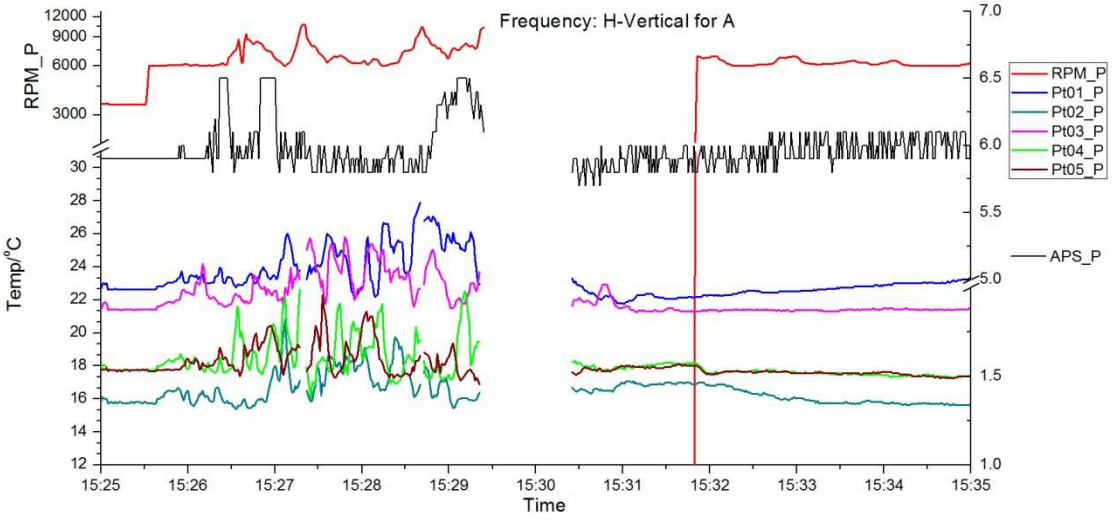


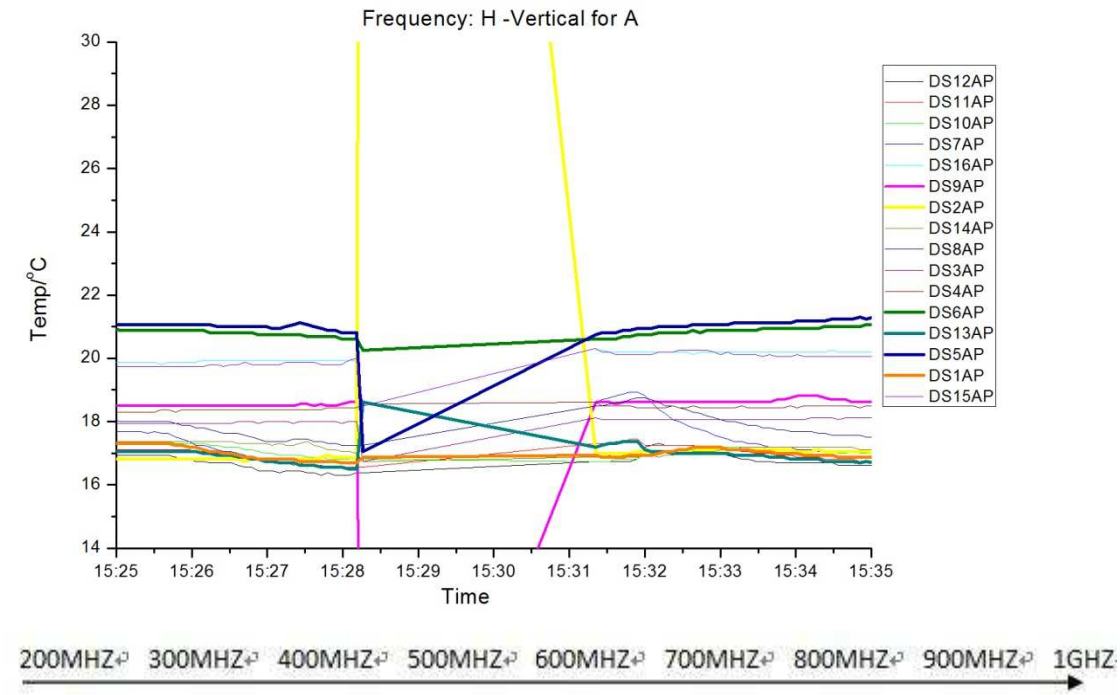
Remarks:

- Increase of Pt1 to 28 C while pressure is still according to 26 C.
- Increase in pump speed with 3000 rpm
- Dallas sensor information to be added

10.2 H-vertical TTCE-A pump speed 6000 rpm

PT1000, APS, RPM and Dallas sensors





Remarks:

- Sudden stop in DS read-out
- Communication failure *** err = 0x110A *** resulting in pump switch off
- Increase of pump speed (248 MHz & 475 MHz)

- APS increase but outside APS showed normal values (248 & 475 MHz)
- Pt1000 increase on all Pt1000's

The Dallas sensor read-out stopped during the test.

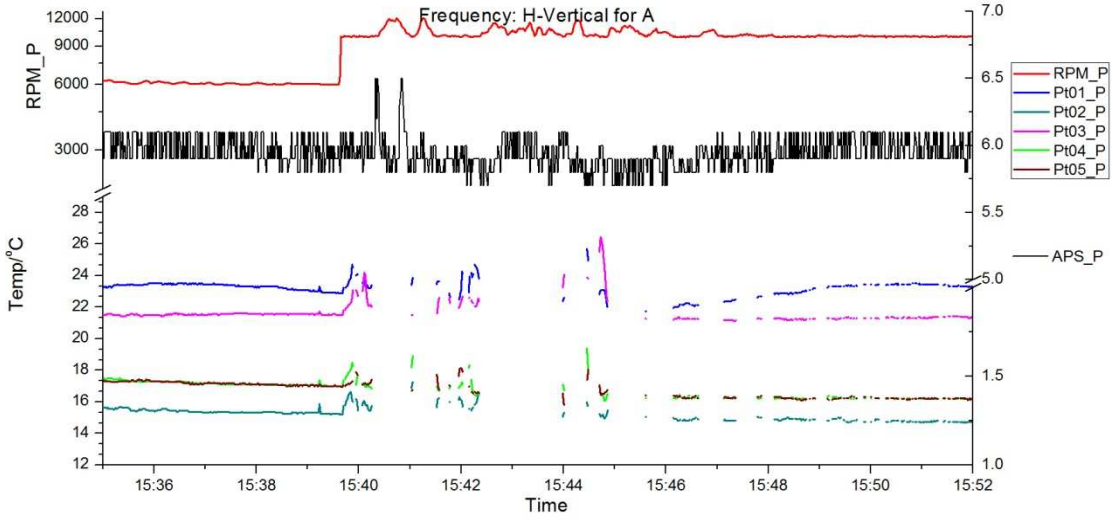
Jun 11 15:28:11 2009 : +16.38 +16.56 +16.81 +16.69 +19.94 +18.62 +16.81 +17.00 +17.25 +18.00 +18.44 +20.62 +16.50 +20.81 +16.69 +20.00 +15.88 +15.69 +0.00
Thu Jun 11 15:28:16 2009 : +16.38 +16.56 +16.81 Thu Jun 11 15:31:15 2009 : +16.75 +17.25 +16.75 +18.56 +20.25 +18.62 +17.06 +16.88 +18.50 +18.12 +18.69 +20.56 +17.19 +20.75 +17.00 +20.38 +16.88 +16.69 +0.00
Thu Jun 11 15:31:21 2009 : +16.75 +17.31 +16.75 +18.62 +20.25 +18.62 +17.00 +16.88 +18.50 +18.12 +18.62 +20.62 +17.19 +20.75 +16.94 +20.31 +16.94 +16.69 +0.00
Thu Jun 11 15:31:26 2009 : +16.75 +17.31 +16.75 +18.69 +20.25 +18.62 +17.00 +16.88 +18.50 +18.06 +18.50 +20.62 +17.25 +20.81 +16.88 +20.19 +16.94 +16.75 +0.00

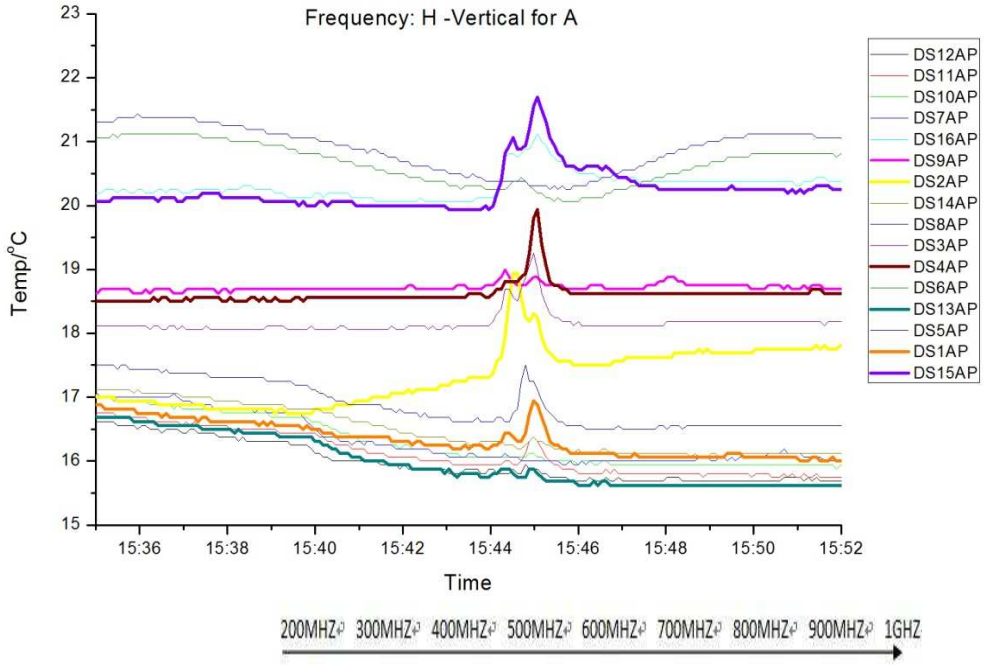
The following data problem was shown just before the moment the pump stopped operating:

2009.06.11 15:29:24 : 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 10346 0 60 90 10 60 90 60 6.1 86.7 0.0 0.6 +23.12 +16.25 +25.88 +18.25 +16.94 +97.69 +98.38 +97.31 +97.75 +98.44 +97.31 +97.75 +97.75 +97.81 +97.75 +97.75 +97.75 +98.44 +97.31 +97.75 +98.44 +97.31
2009.06.11 15:29:25 *** err = 0x110A ***
2009.06.11 15:29:26 *** err = 0x110A ***
2009.06.11 15:29:27 *** err = 0x110A ***
2009.06.11 15:29:28 *** err = 0x110A ***
2009.06.11 15:29:29 *** err = 0x110A ***
2009.06.11 15:29:30 *** err = 0x110A ***
2009.06.11 15:29:31 *** err = 0x110A ***
2009.06.11 15:29:32 *** err = 0x110A ***
2009.06.11 15:29:33 *** err = 0x110A ***
2009.06.11 15:29:34 *** err = 0x110A ***
2009.06.11 15:29:35 *** err = 0x110A ***
2009.06.11 15:29:36 *** err = 0x110A ***
2009.06.11 15:29:37 *** err = 0x110A ***
2009.06.11 15:29:38 *** err = 0x110A ***
2009.06.11 15:29:39 *** err = 0x110A ***
2009.06.11 15:29:40 *** err = 0x110A ***
2009.06.11 15:29:41 *** err = 0x110A ***
2009.06.11 15:29:42 *** err = 0x110A ***
2009.06.11 15:29:43 *** err = 0x110A ***
2009.06.11 15:29:44 *** err = 0x110A ***
2009.06.11 15:29:45 *** err = 0x110A ***
2009.06.11 15:29:46 *** err = 0x110A ***
2009.06.11 15:29:47 *** err = 0x110A ***
2009.06.11 15:29:48 *** err = 0x110A ***
2009.06.11 15:29:49 *** err = 0x110A ***
2009.06.11 15:30:25 : 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 60 90 10 60 90 60 5.8 1.7 0.0 0.2 +23.31 +16.69 +21.62 +18.25 +17.62 +97.81 +97.19 +97.31 +97.88 +97.19 +97.31 +97.31 +97.31 +97.31 +97.31 +97.31 +97.81 +97.19 +97.31 +97.81 +97.19 +97.31

10.3 H-vertical TTCE-A pump speed 10,000 rpm

PT1000, APS, RPM and Dallas sensors



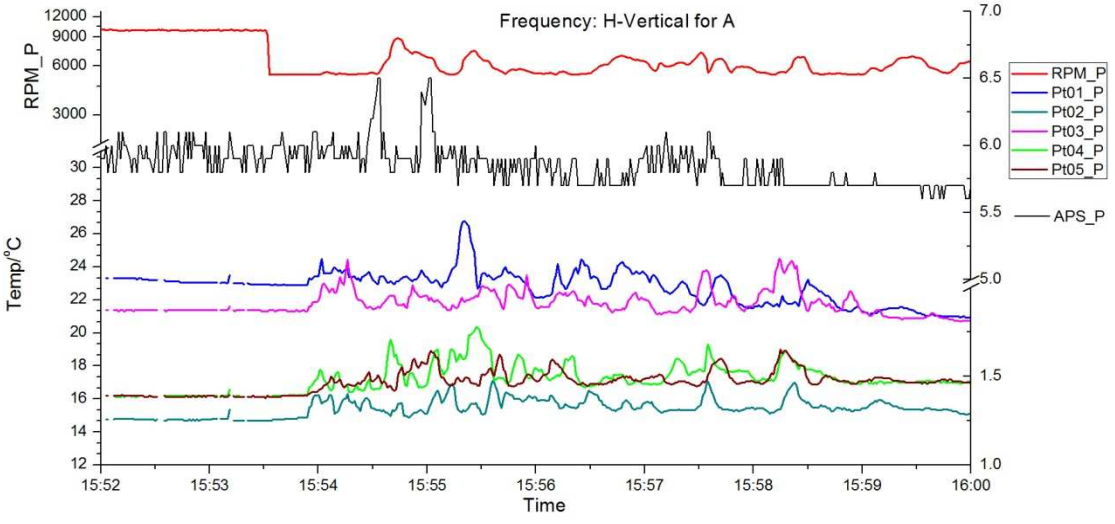


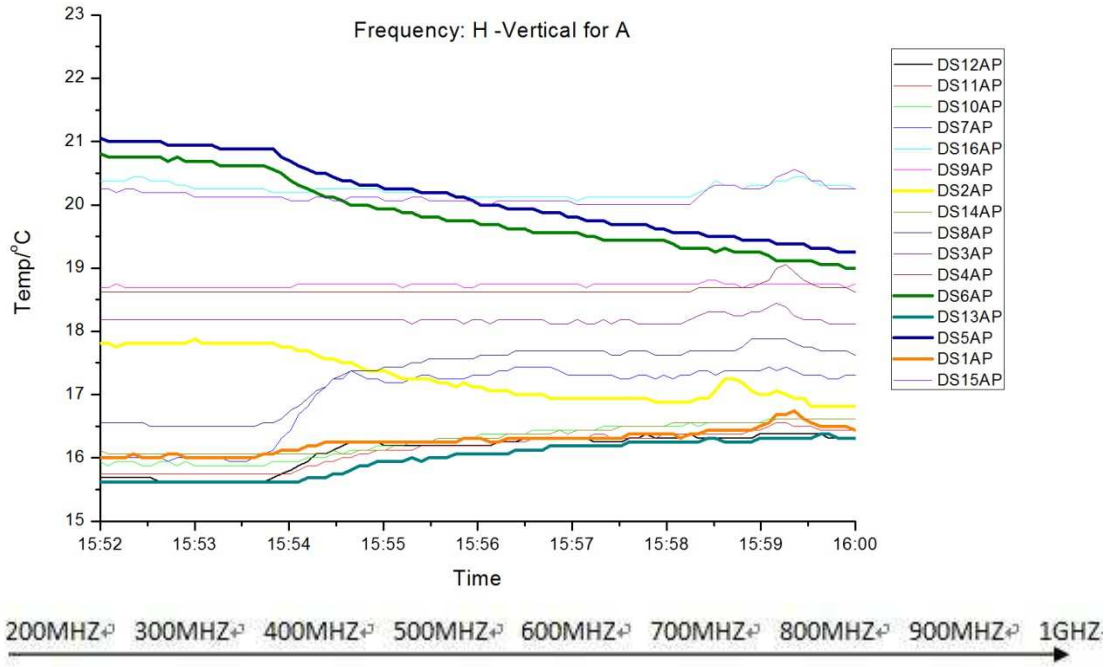
Remarks:

- Pump speed increase and APS noise
- Missing data is an import failure into figures don't pay attention (will be solved)
- DS sensor susceptibility leading to T-increase

10.4 H-vertical TTCE-A pump speed 6,000 rpm (repeated)

PT1000, APS, RPM and Dallas sensors



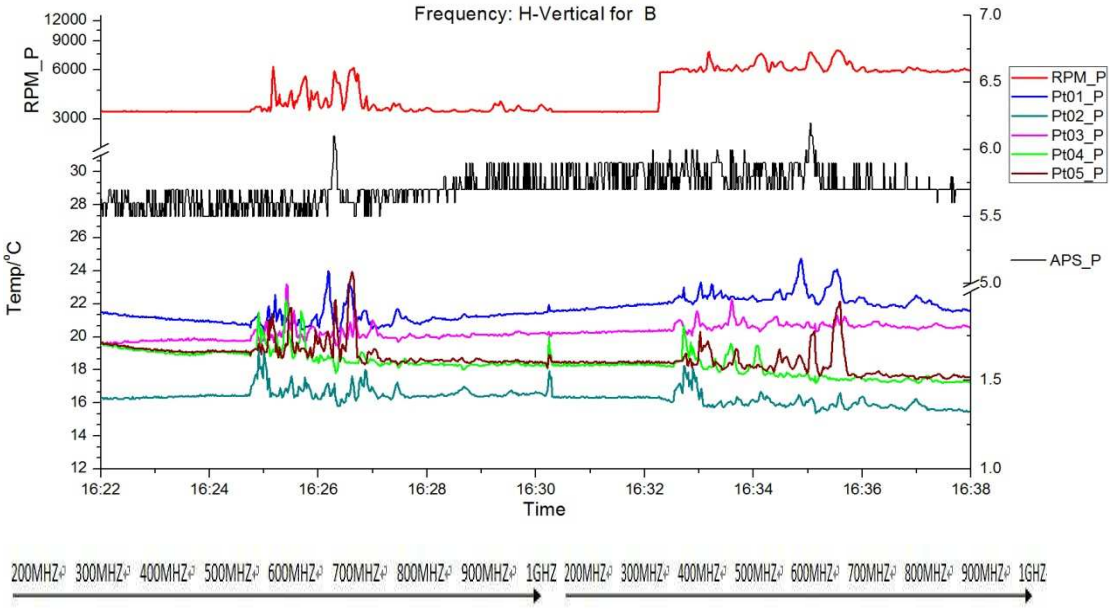


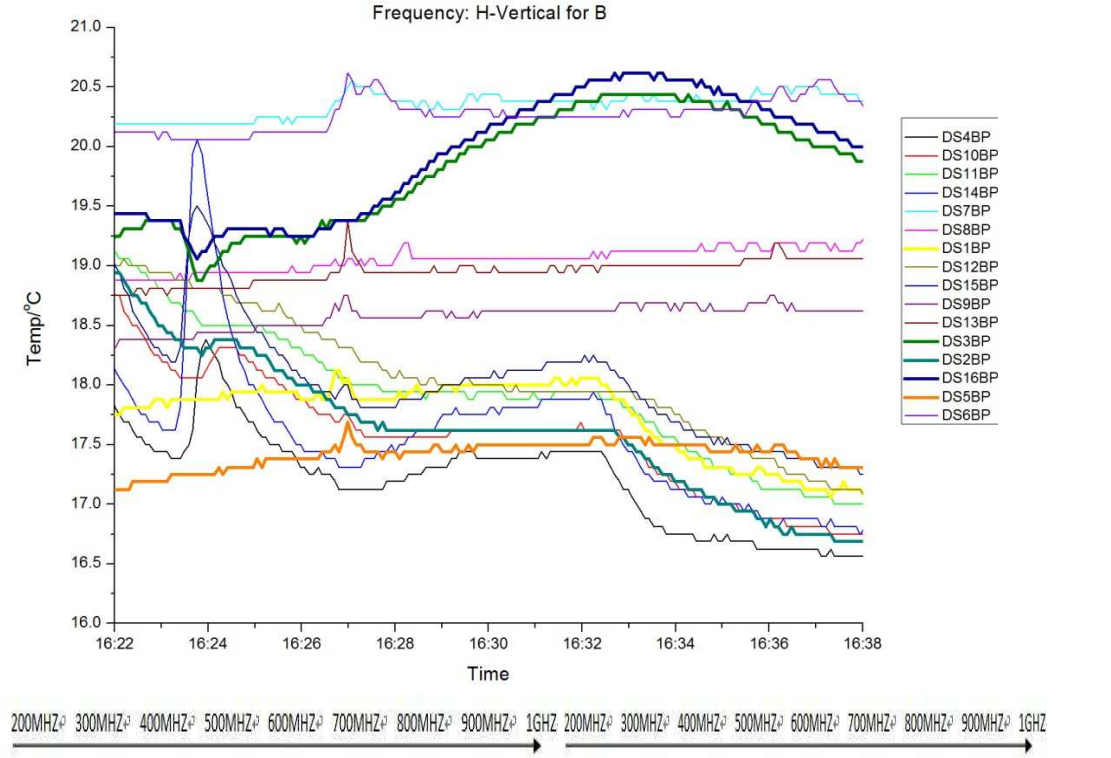
Remarks:

- Increase of pump speed, the pump stop is not repeated
- APS noise
- DS output not affected

10.5 H-vertical TTCE-B pump speed 3500 rpm and 6000 rpm

PT1000, APS, RPM and Dallas sensors



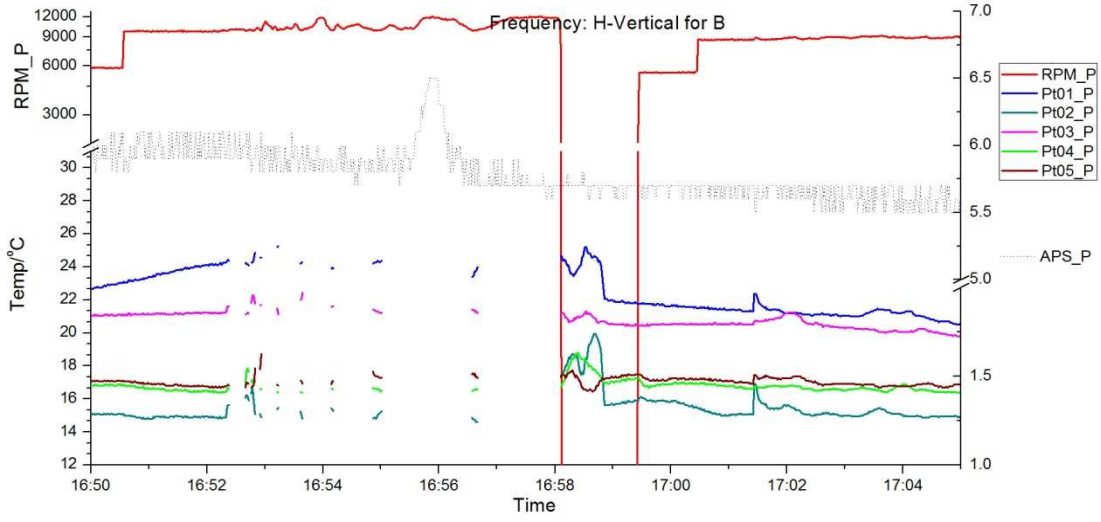


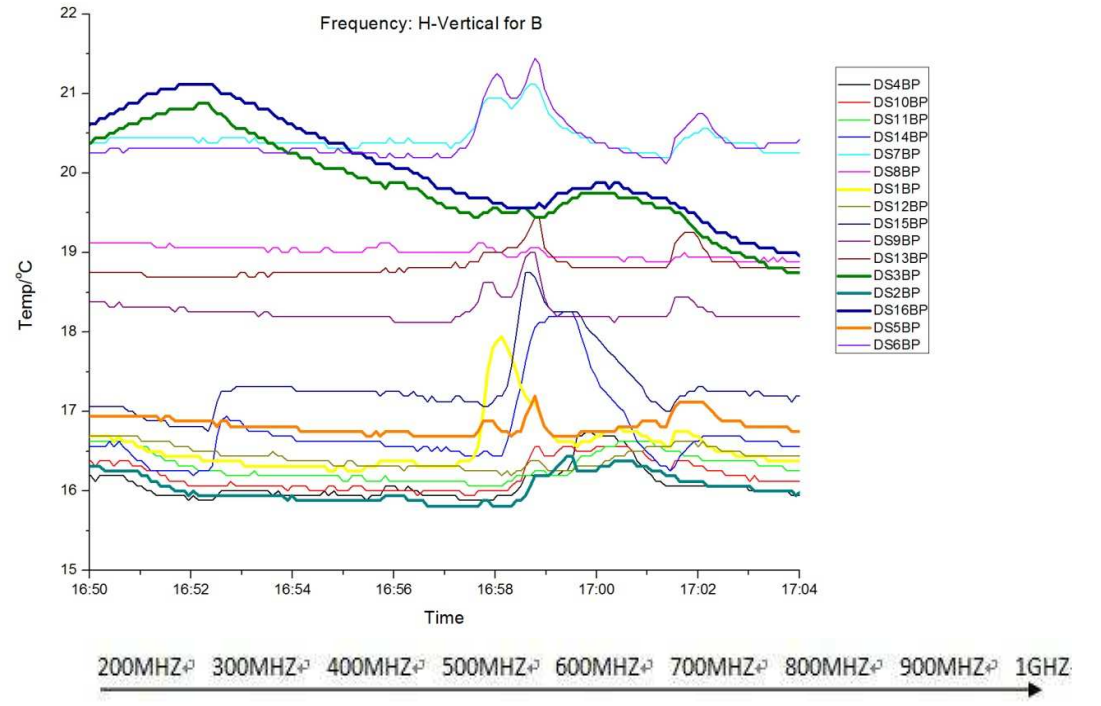
Remarks:

- Pump speed variations, Pt1000 variations, APS noise, no DS anomalies

10.6 H-vertical TTCE-B pump speed 10,000 rpm

PT1000, APS, RPM and Dallas sensors



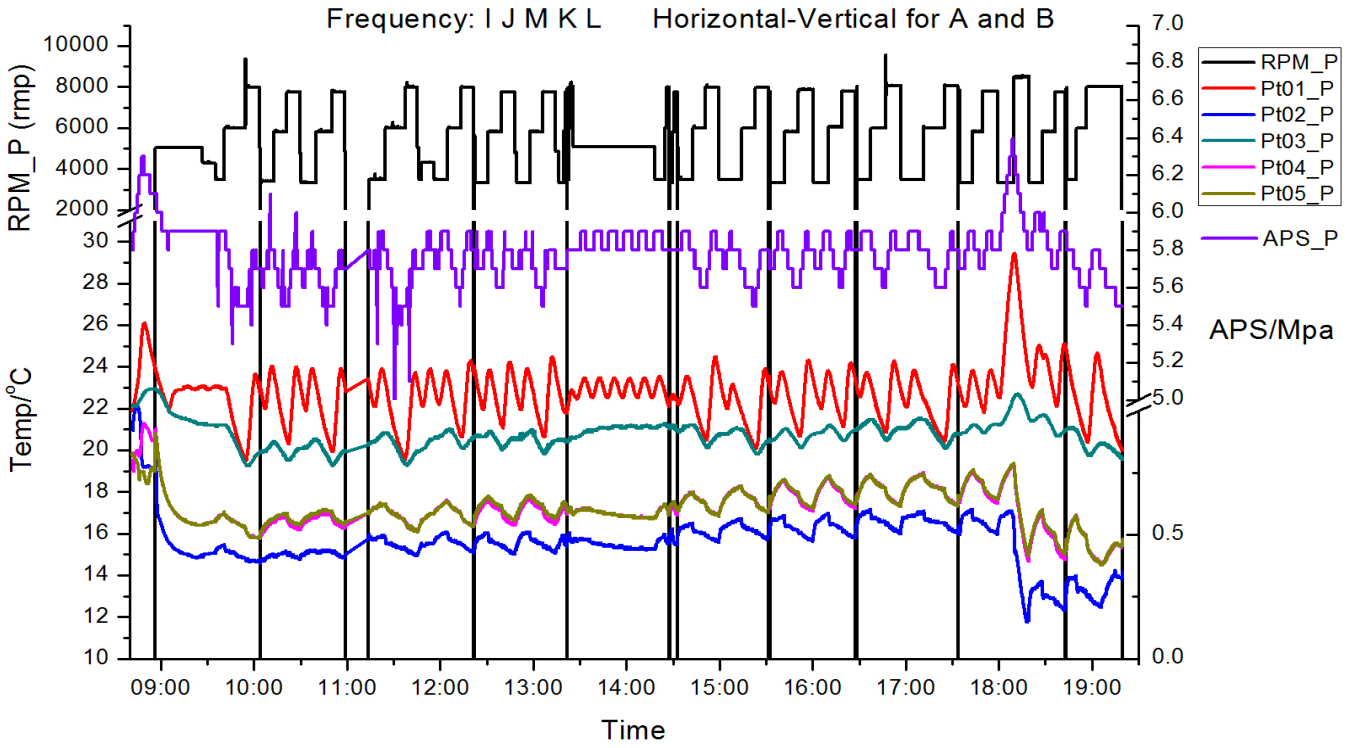


Remarks:

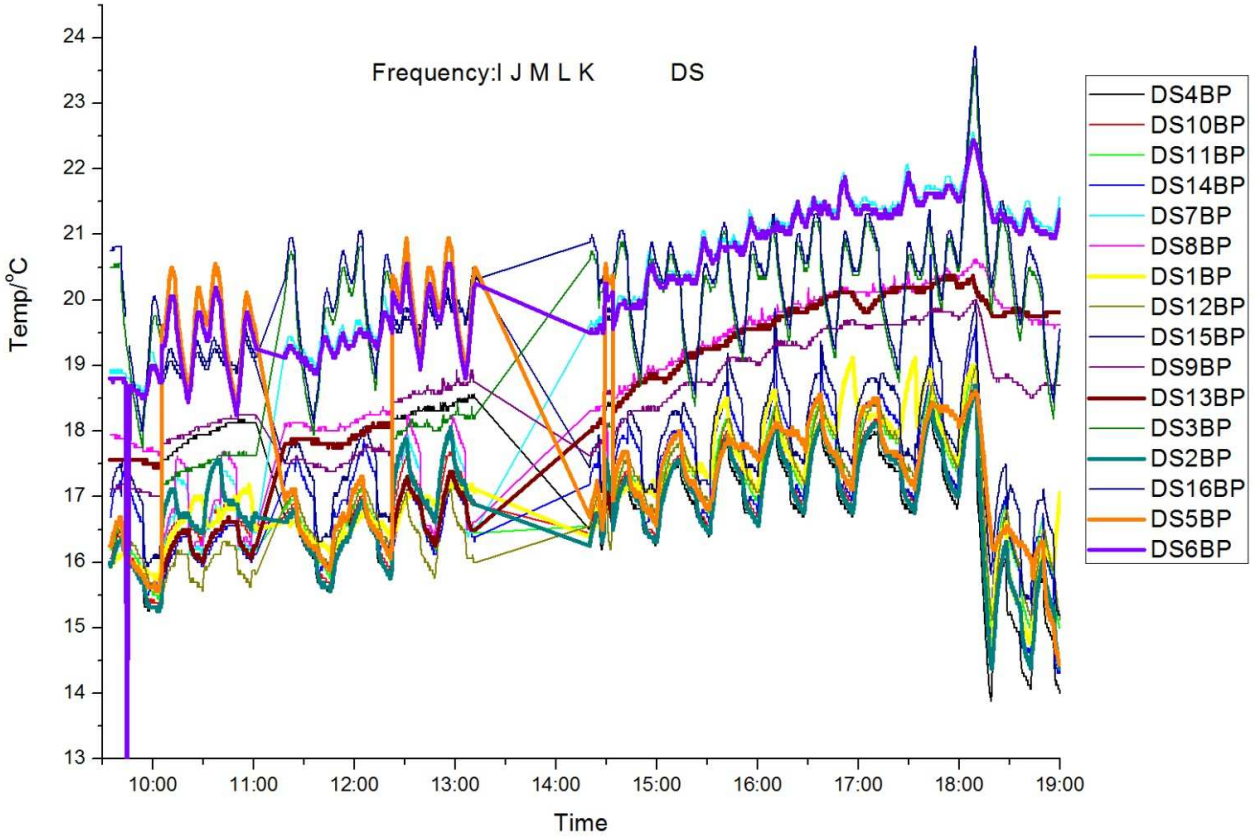
- Communication failure during for rpm>10,000
- Manual switched off pump

11 Frequency: I J M K L

PT1000, Pump speed and APS



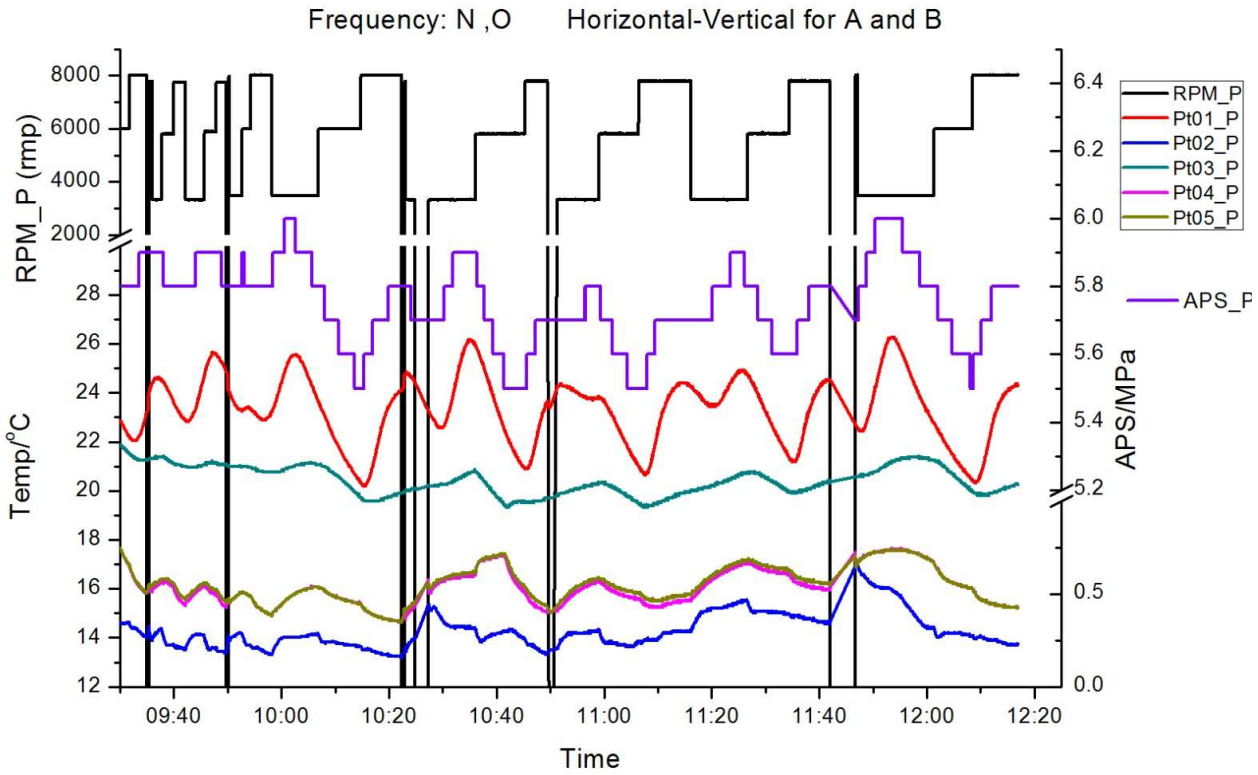
Dallas sensors



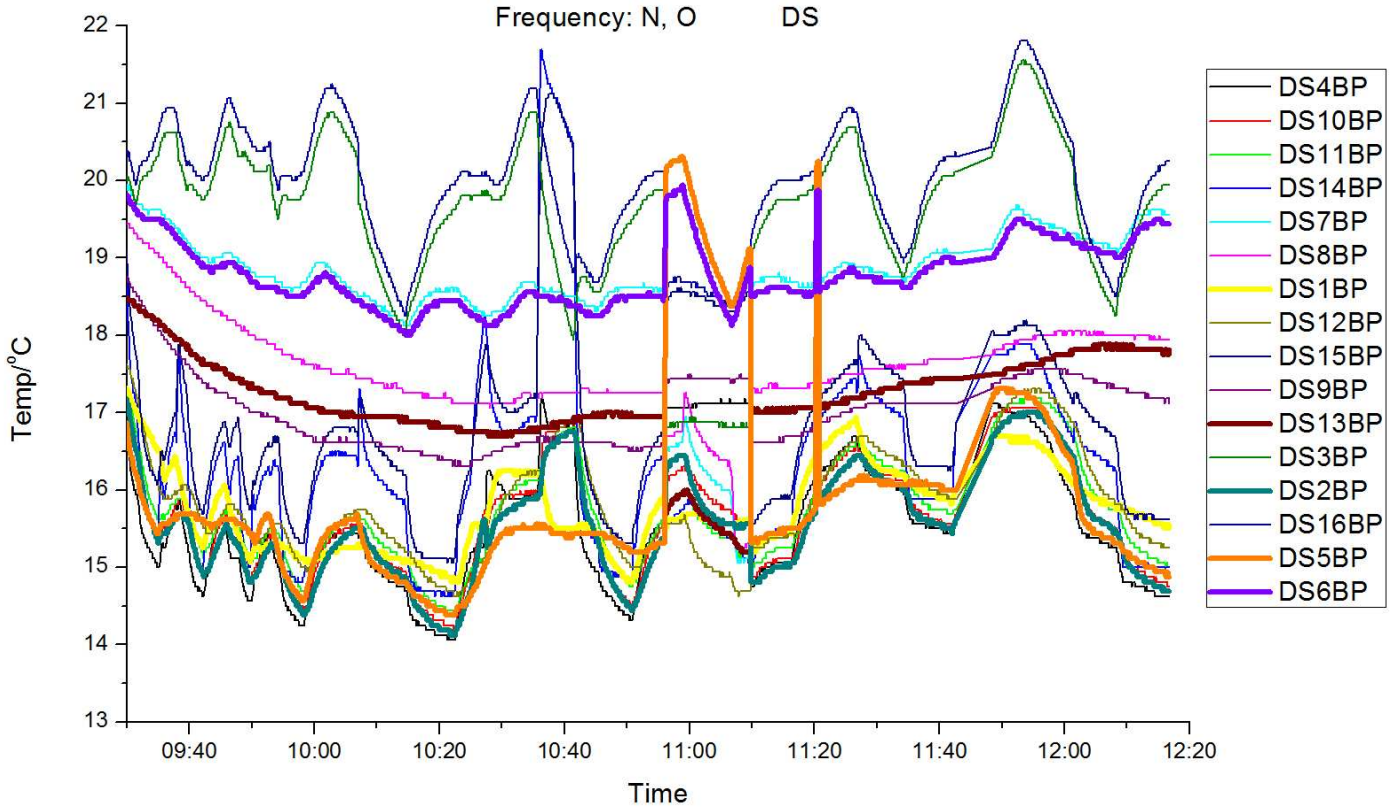
The hick-up in the data is missing data due to a missing file. This is not due to the EM-field but a file storage failure.

12 Frequency: N, O.

PT1000, Pump speed and APS



Dallas sensor data


Frequency: N, O DS
Temp/°C
Time
22
21
20
19
18
17
16
15
14
13
09:40
10:00
10:20
10:40
11:00
11:20
11:40
12:00
12:20
DS4BP
DS10BP
DS11BP
DS14BP
DS7BP
DS8BP
DS1BP
DS12BP
DS15BP
DS9BP
DS13BP
DS3BP
DS2BP
DS16BP
DS5BP
DS6BP

13 Conclusions

Overall the TTCB survived the EMI-EMC test campaign. No degradation in functional behaviour was found after the test.

13.1 EMI test results

All TTCB and TTCE radiated emission are below the requirement levels.

13.2 EMS Interference test results

However the TTCB/TTCE set-up showed to be susceptible to both horizontal and vertical H-fields (200 MHz-1 GHz).

The following anomalies take place:

1. Pump speed increase upto approximately 3500 rpm
2. Pt1000 increase with max 4 degrees ºC
3. DS increase of maximum 2.5 ºC. Especially spare DS (not attached to any construction) are susceptible (DS14 & DS16).
4. APS noise
5. A possible communication problem was found resulting in switch off of the pump (not reproducible)

The pump susceptibility was also found during the pump EMI/EMC testing. It was decided not to shield the pump as additional flow does not have major impact on the Tracker temperature.

The Pt1000 sensor T-variations (especially) specifically Pt1 and Pt2 will impact Tracker temperature stability. The Tracker will go up and down with the variation in Pt1 and the cavitation health guard will be impacted by variations in Pt2.

The impact of Dallas sensor and APS susceptibility is less severe as these are only used form monitoring purposes.

A “communication” error occurred during the test resulting in system and pump switch off.

Most likely cause of the susceptibility and “communication” error is the lack of cable shielding between TTCE and TTCB or shielding of TTCB internal cabling.

13.3 Proposed next steps

In order to check if cable shielding will solve the problem H-field test with TTCE could be done to discriminate between TTCE-TTCB cabling shielding or internal box shielding of Pt1000- DS and actuator sensor.
Based on that information it can be decided if cable shielding is a possible solution to the susceptibility.

The pump speed susceptibility was also detected during pump testing. It is not needed to shield the pump as it has no influence on operation.

The communication S/W error should be investigated on order to understand what caused the system shut down.

END OF DOCUMENT